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**Lin et al.**

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(54) **OPTICAL IMAGING LENS AND  
ELECTRONIC DEVICE COMPRISING THE  
SAME**

USPC ..... 359/713  
See application file for complete search history.

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(51) **Int. Cl.**

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**H04N 5/225** (2006.01)

**G02B 13/00** (2006.01)

**G03B 13/32** (2006.01)

**G03B 17/12** (2006.01)

(52) **U.S. Cl.**

CPC ..... **H04N 5/2254** (2013.01); **G02B 13/0045**  
(2013.01); **G03B 13/32** (2013.01); **G03B 17/12**  
(2013.01)

(58) **Field of Classification Search**

CPC ..... G02B 13/0045

(56) **References Cited**

U.S. PATENT DOCUMENTS

7,826,151 B2	11/2010	Tsai	
8,000,030 B2	8/2011	Tang	
8,000,031 B1	8/2011	Tsai	
8,310,768 B2	11/2012	Lin et al.	
8,363,337 B2	1/2013	Tang et al.	
8,542,448 B2	9/2013	Shinohara	
2007/0229984 A1	10/2007	Shinohara	
2007/0236811 A1	10/2007	Mori	
2012/0162769 A1*	6/2012	Suzuki et al.	359/558
2013/0077181 A1	3/2013	Chen et al.	
2013/0100542 A1	4/2013	Tsai et al.	

FOREIGN PATENT DOCUMENTS

CN	103293637 A	9/2013
CN	103309020 A	9/2013
TW	201007340	2/2010
TW	201135304	10/2011
TW	201213926	4/2012
TW	201215942	4/2012
TW	201224506	6/2012

(Continued)

Primary Examiner — James Jones

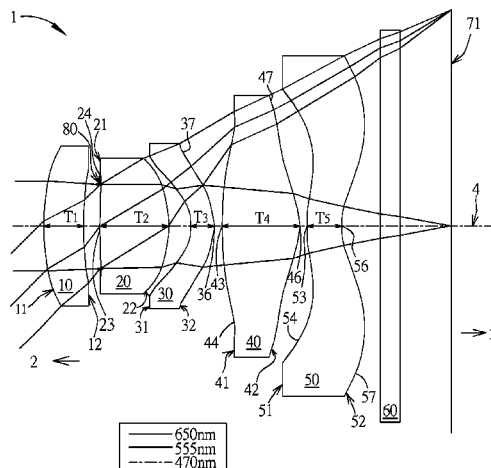
(74) Attorney, Agent, or Firm — Winston Hsu; Scott Margo

(57)

**ABSTRACT**

An optical imaging lens set includes a first lens element to a plastic fifth lens element from an object side toward an image side along an optical axis. Each first lens and second lens element has positive refractive power. The third lens element has an image-side surface with a convex portion in a vicinity of the optical axis. The fourth lens element has an image-side surface with a convex portion in a vicinity of the optical axis. The fifth lens element has an image-side surface with a concave portion in a vicinity of the optical axis and a convex portion in a vicinity of its periphery.

**18 Claims, 28 Drawing Sheets**



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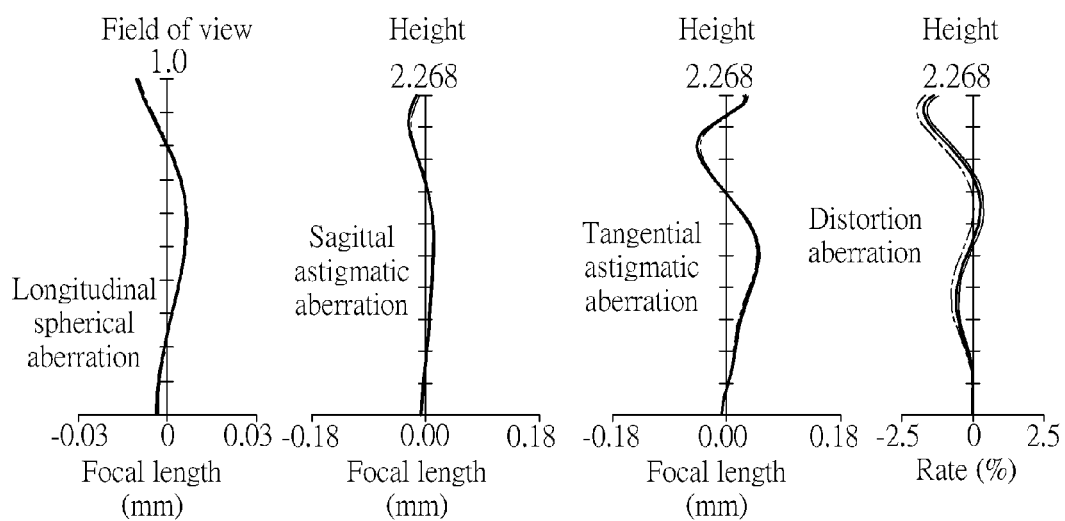
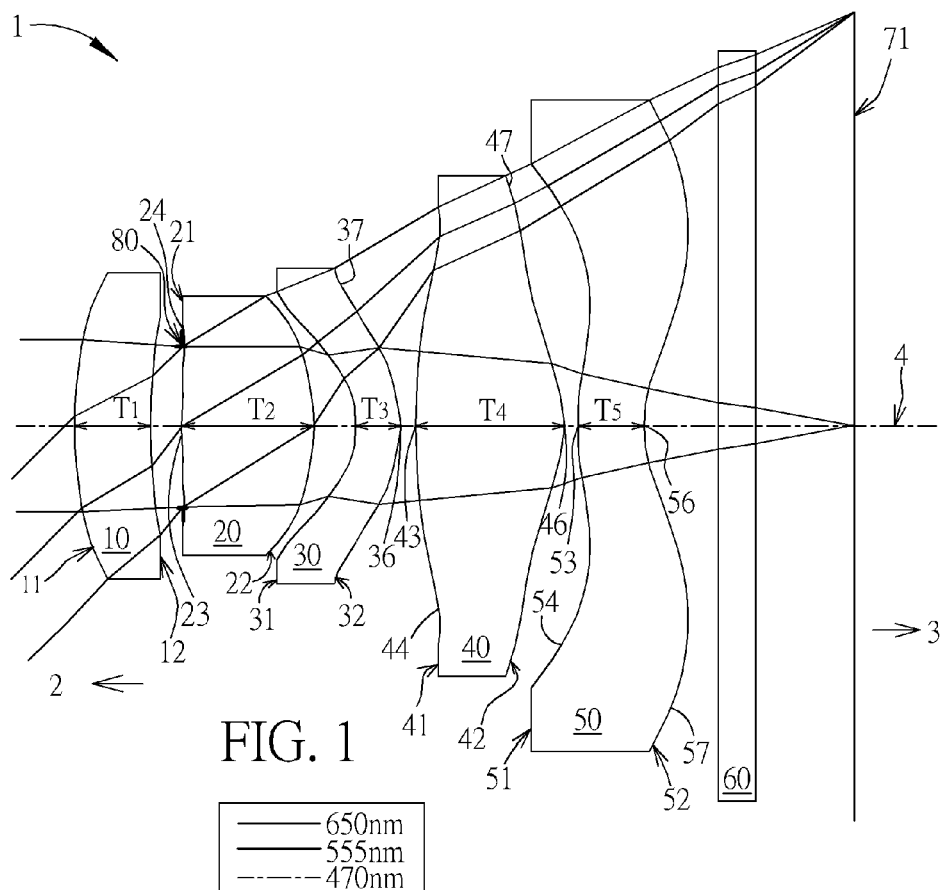
## References Cited

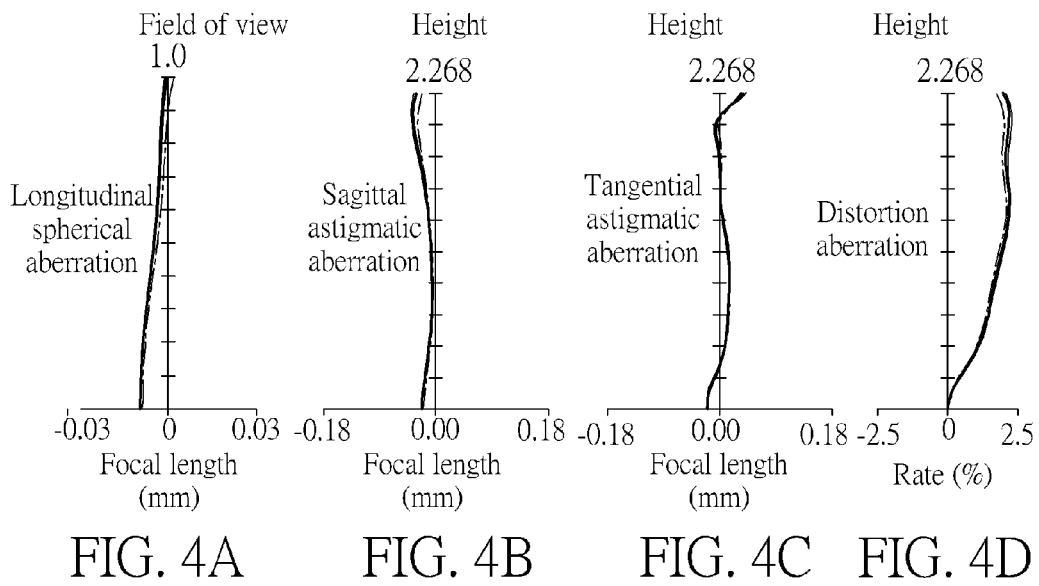
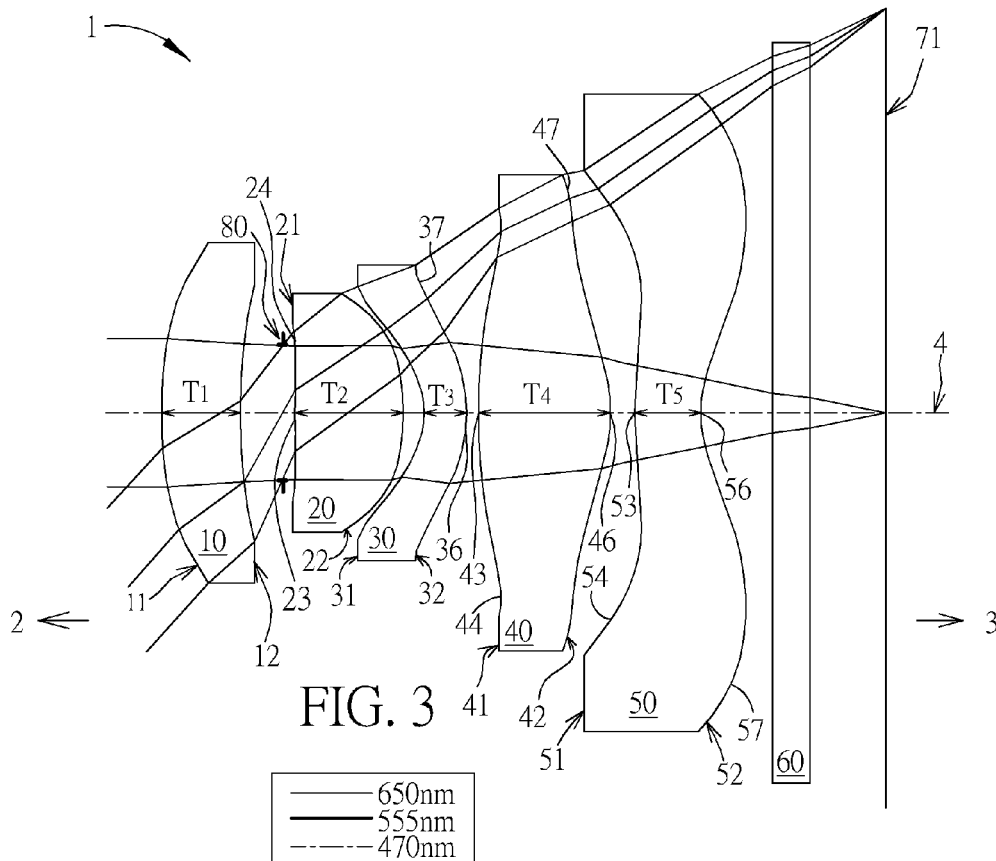
### FOREIGN PATENT DOCUMENTS

TW	201237455	9/2012
TW	201239444	10/2012

TW	201250282	12/2012
TW	I390244	3/2013
TW	201314251	4/2013
TW	201335619	9/2013
TW	201341837	10/2013

\* cited by examiner





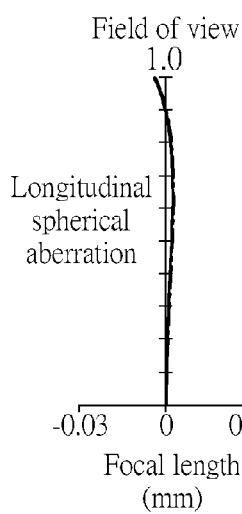
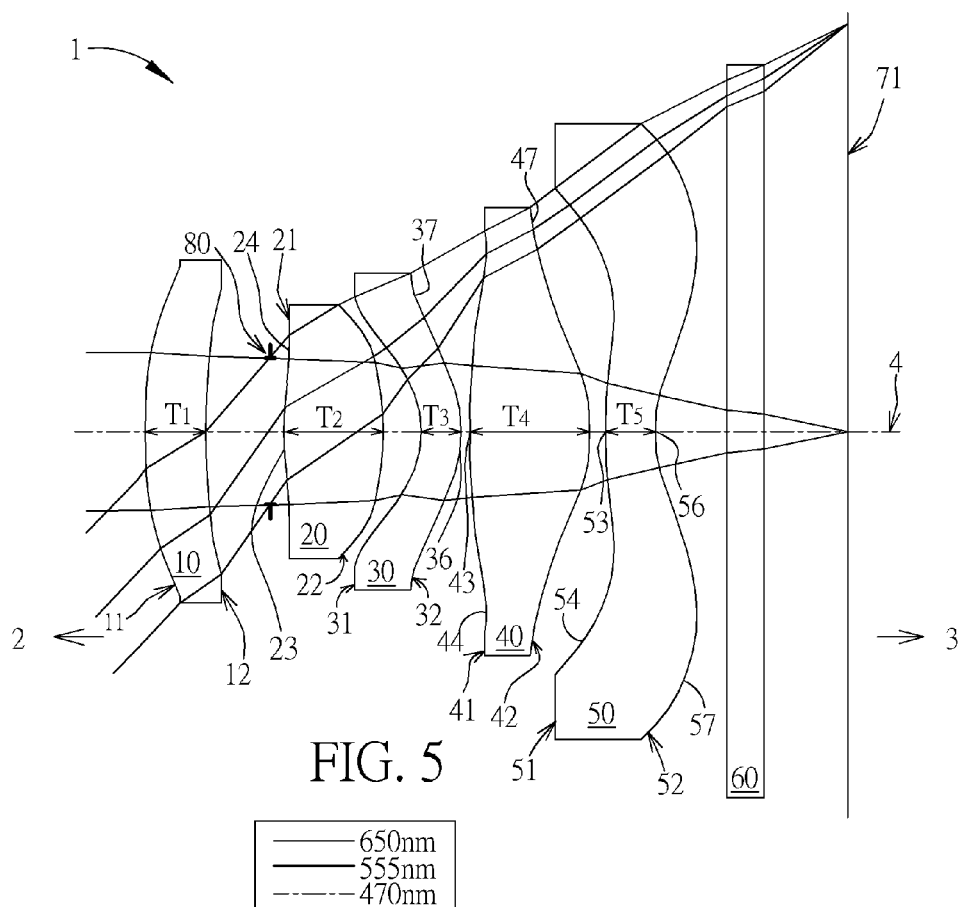


FIG. 6A

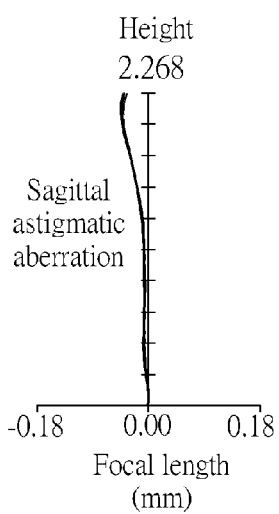


FIG. 6B

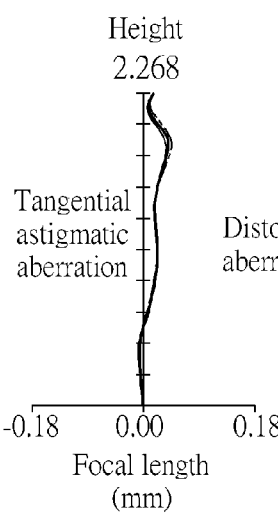


FIG. 6C

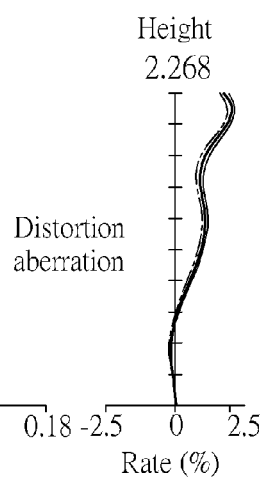


FIG. 6D

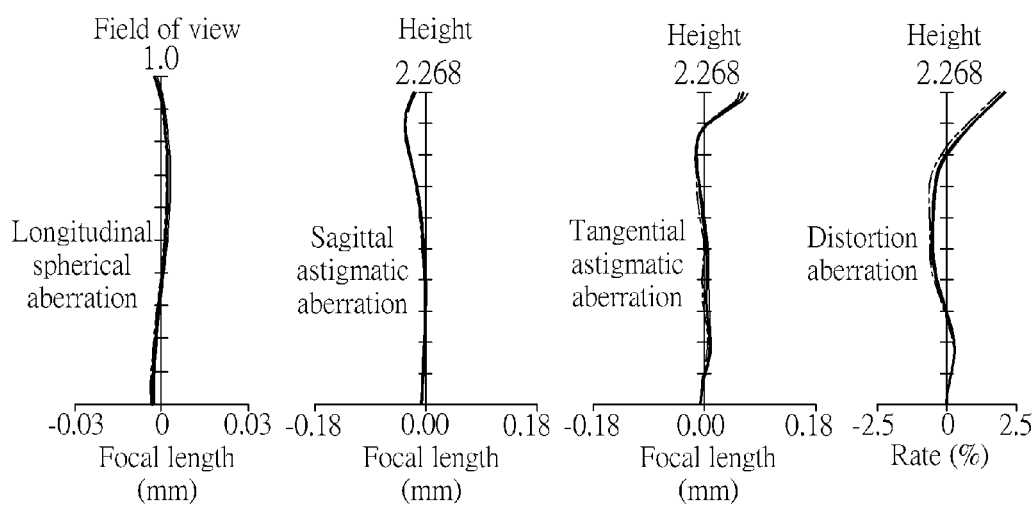
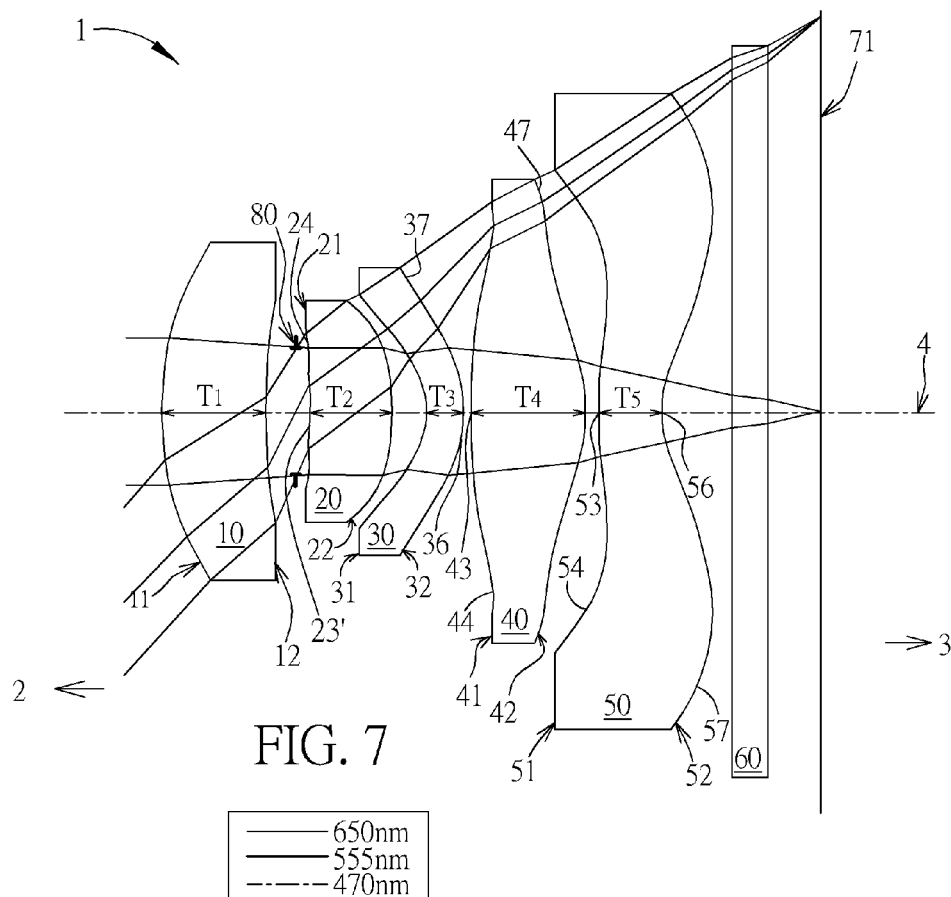


FIG. 8A

FIG. 8B

FIG. 8C

FIG. 8D

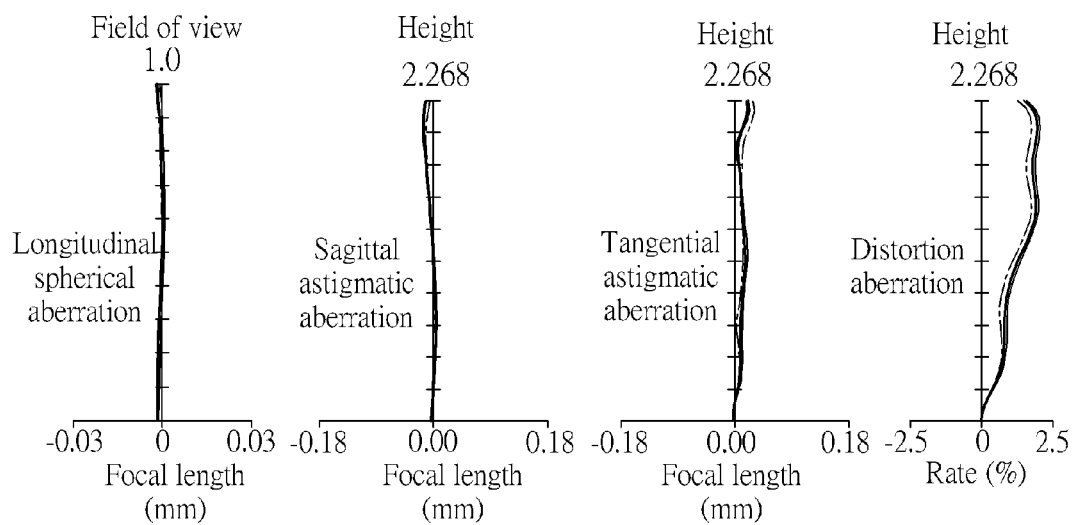
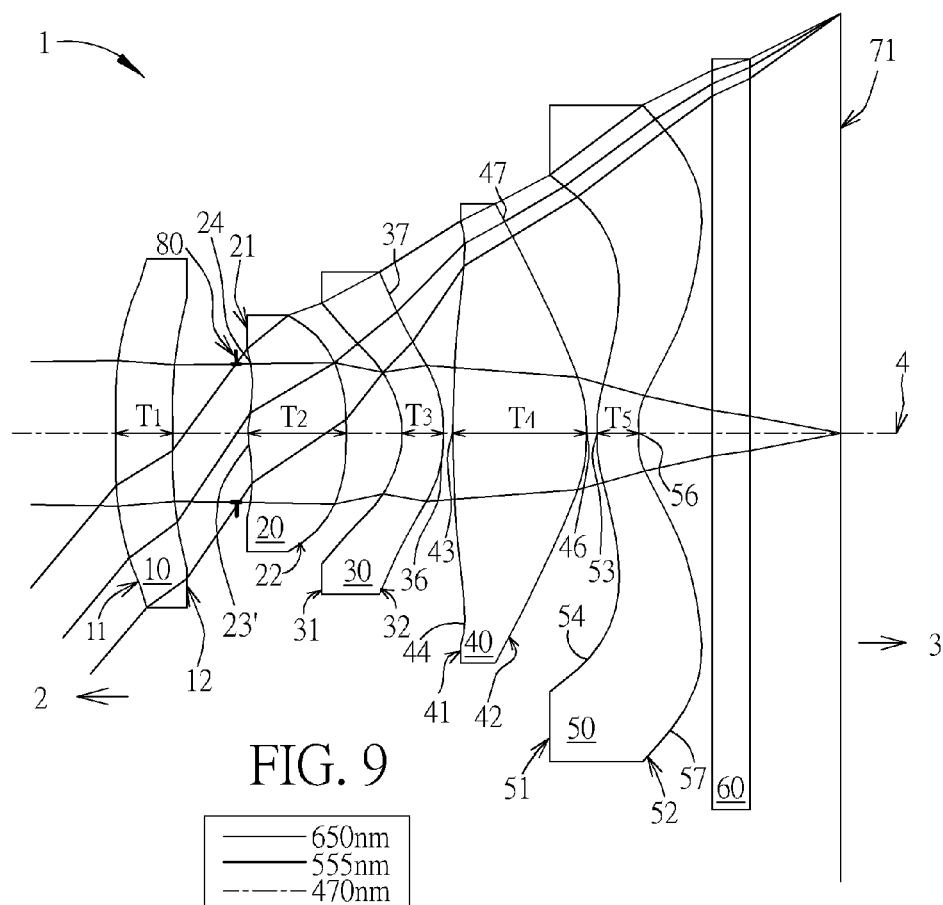
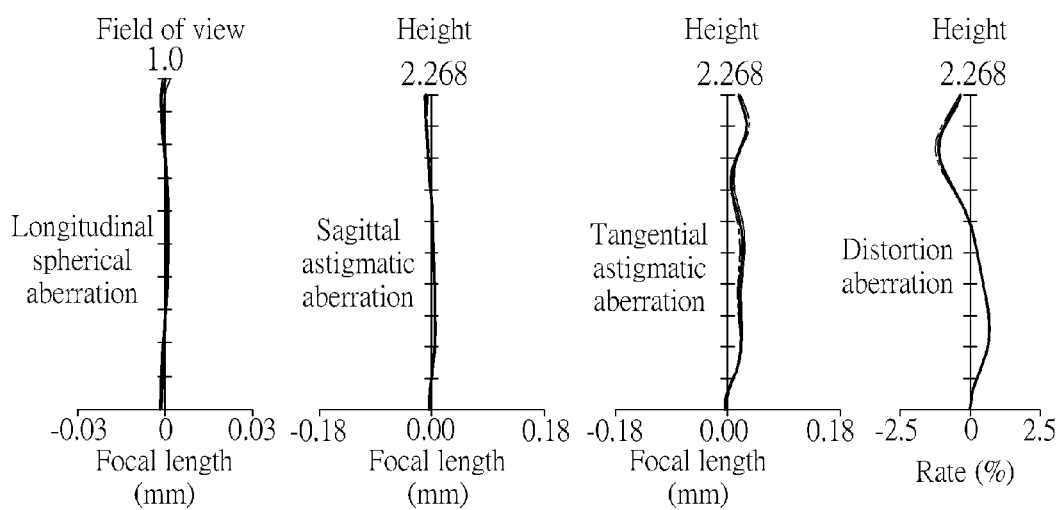
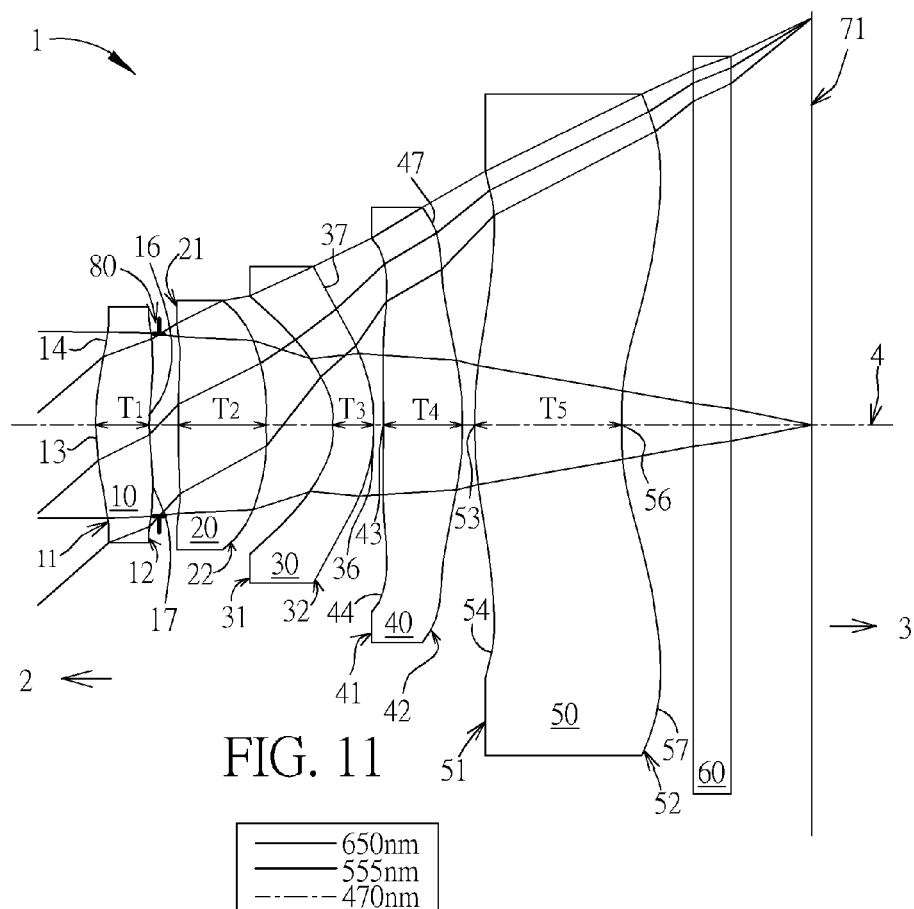


FIG. 10A

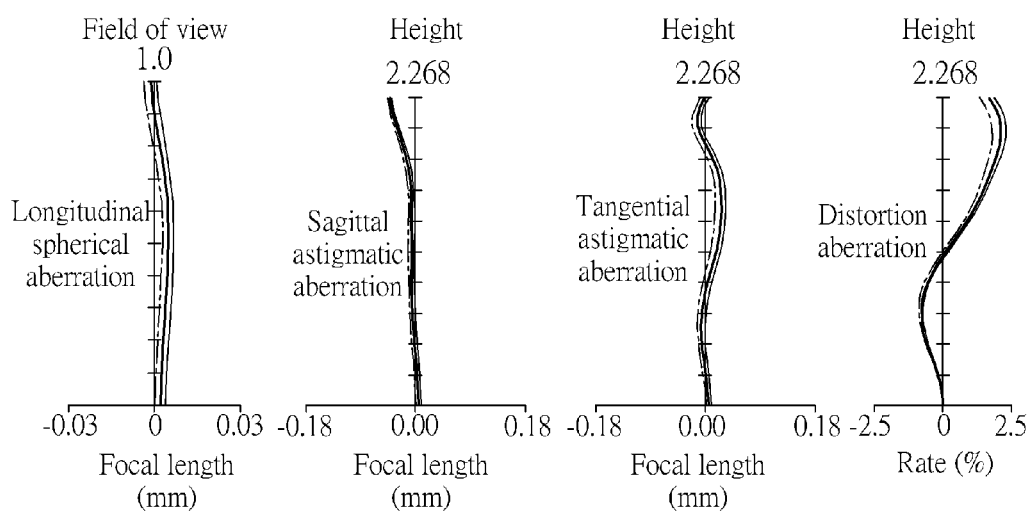
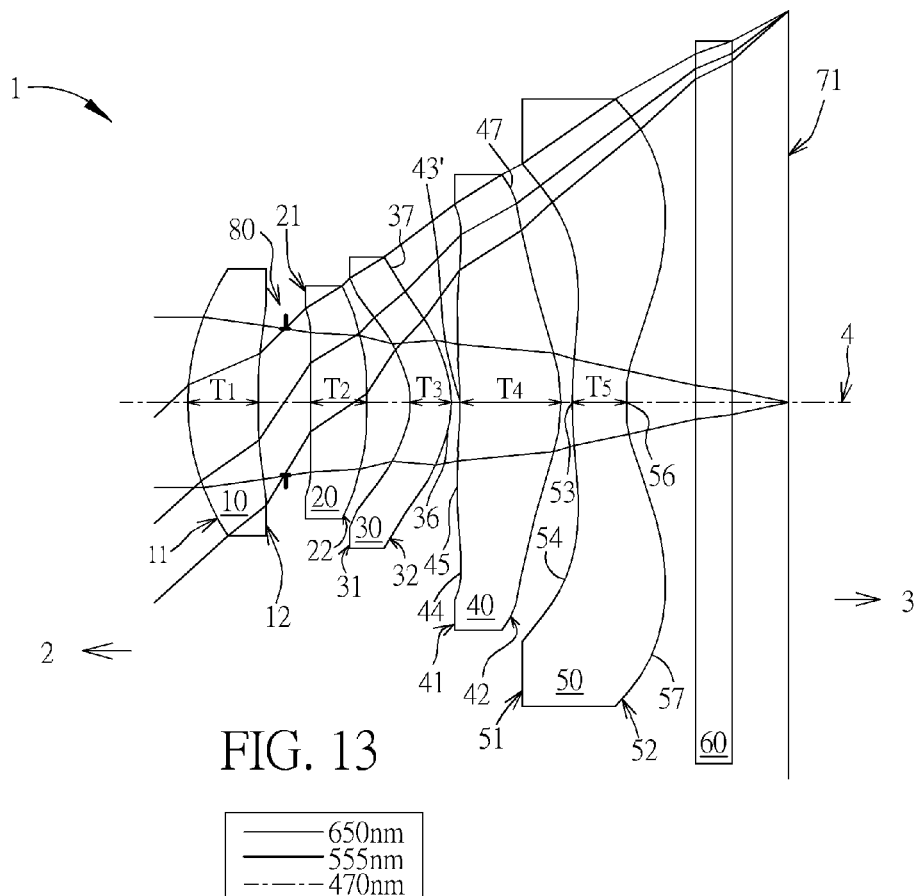
FIG. 10B

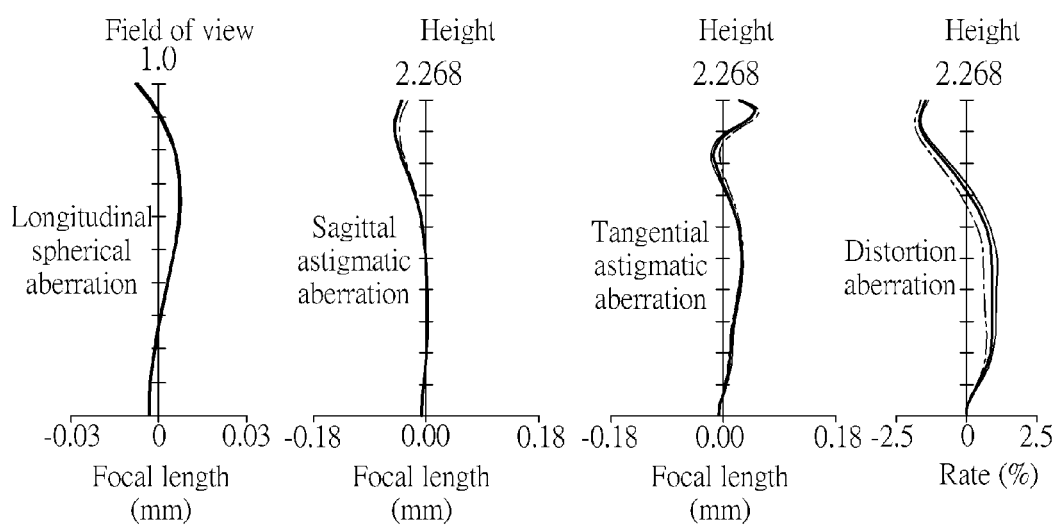
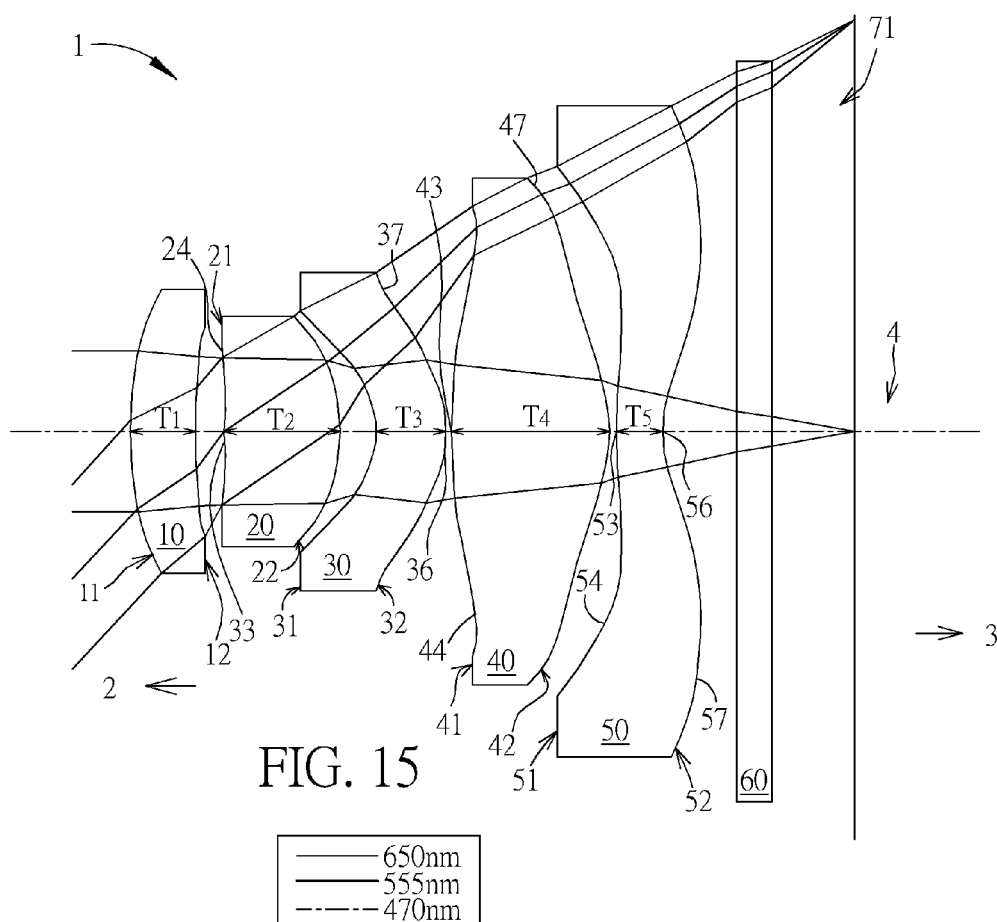
FIG. 10C

FIG. 10D









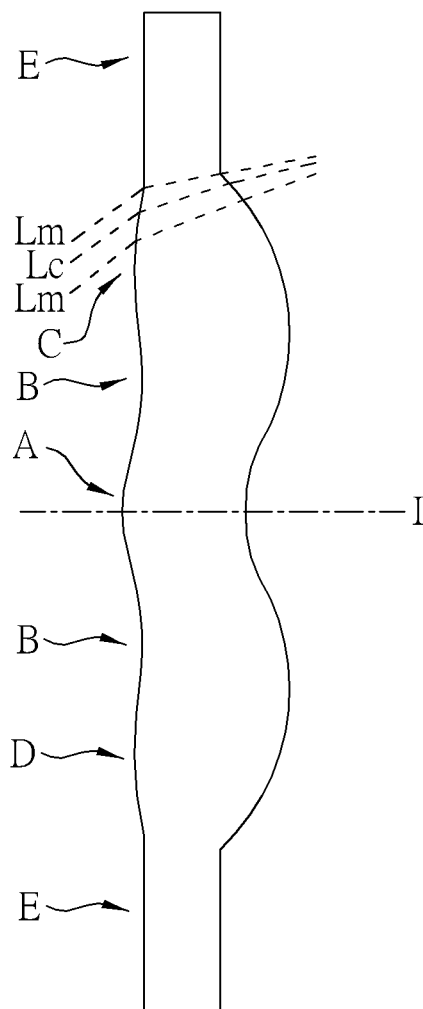


FIG. 17

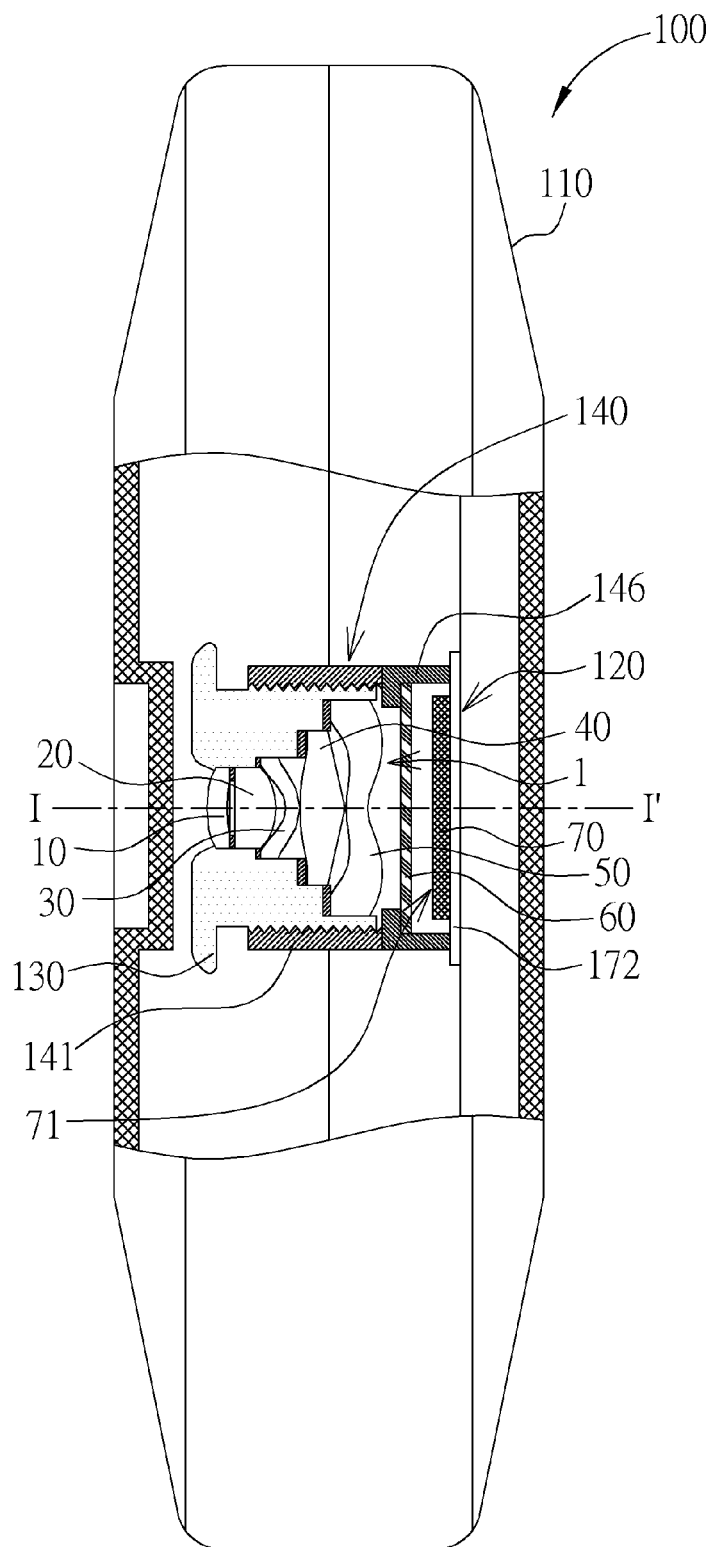


FIG. 18

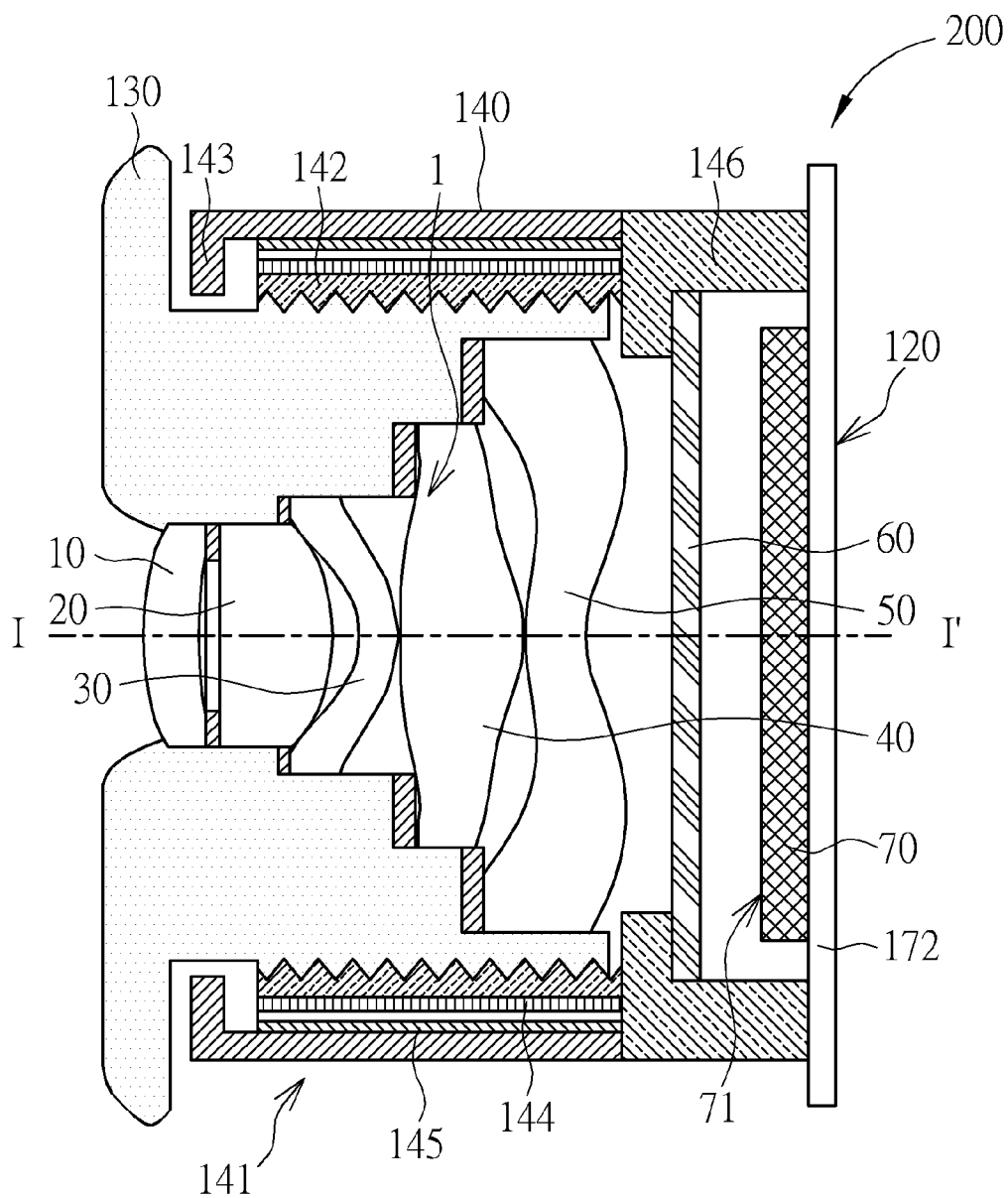


FIG. 19

First Example							
F= 2.291 mm, HFOV= 44.813 deg., Fno= 2.403							
No.		Curvature Radius	Apc. Stop Distance Lens Thickness Air Gap	Refractive Index	Abbe No.	Focal Length	Material
	Object	Infinity	500				
		Infinity	0.050				
11	First Lens	2.739	0.413 T <sub>1</sub>	1.535	55.711	10.532	plastic
12		5.034	0.164 G <sub>12</sub>				
80	Ape. Stop	Infinity	0.007				
21	Second Lens	14.964	0.709 T <sub>2</sub>	1.535	55.711	2.687	plastic
22		-1.5704	0.237 G <sub>23</sub>				
31	Third Lens	-0.492	0.238 T <sub>3</sub>	1.638	23.256	-3.564	plastic
32		-0.745	0.080 G <sub>34</sub>				
41	Fourth Lens	4.654	0.801 T <sub>4</sub>	1.535	55.711	1.402	plastic
42		-0.844	0.083 G <sub>45</sub>				
51	Fifth Lens	2.132	0.353 T <sub>5</sub>	1.638	23.256	-1.539	plastic
52		0.632	0.400				
60	IR Filter	Infinity	0.210				
	IR Filter- Image Plane	Infinity	0.537				
71	Image Plane	Infinity					

FIG. 20

No.	11	12	21	22	31
K	-5.823E+00	7.288E+00	0.000E+00	2.010E-01	-6.766E-01
a4	1.240E-01	2.195E-01	-1.210E-01	-2.537E-01	4.384E-01
a6	1.068E-02	-2.946E-01	1.476E-01	-4.306E-01	3.414E-01
a8	-3.367E-02	-1.223E-01	-2.618E-01	9.807E-01	1.305E+00
a10	1.457E-02	1.391E-01	-2.735E+00	-7.378E-01	-2.020E-01
a12	-1.888E-02	-1.200E-01	-2.723E+00	-2.316E-01	3.345E-01
a14	1.016E-02	-2.737E-01	-2.603E+00	9.455E-02	0.000E+00
a16	-2.867E-02	1.547E-01	0.000E+00	0.000E+00	0.000E+00
a18	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00
No.	32	41	42	51	52
K	-8.722E-01	4.686E+00	-7.633E+00	-1.533E+00	-5.713E+00
a4	1.439E-01	6.465E-02	6.698E-02	-2.466E-01	-1.420E-01
a6	1.998E-01	-2.108E-02	7.344E-03	-7.496E-03	4.356E-02
a8	3.437E-02	-9.077E-02	-6.826E-03	3.188E-02	-9.444E-03
a10	-2.732E-01	1.207E-01	-1.065E-02	-1.315E-03	1.256E-03
a12	3.223E-01	-7.663E-02	9.345E-04	-2.080E-03	1.361E-04
a14	0.000E+00	1.341E-02	2.221E-03	-9.833E-05	-1.385E-04
a16	0.000E+00	1.950E-03	-4.842E-04	1.601E-04	2.277E-05
a18	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00

FIG. 21

Second Example							
F= 1.975 mm, HFOV= 47.863 deg., Fno= 2.476							
No.		Curvature Radius	Ape. Stop Distance Lens Thickness Air Gap	Refractive Index	Abbe No.	Focal Length	Material
	Object	Infinity	500.000				
		Infinity	0.050				
11	First Lens	2.664	0.440 T <sub>1</sub>	1.535	55.711	10.289	plastic
12		4.850	0.233 G <sub>12</sub>				
80	Apc. Stop	Infinity	0.071				
21	Second Lens	23.719	0.606 T <sub>2</sub>	1.535	55.711	2.235	plastic
22		-1.252	0.115 G <sub>23</sub>				
31	Third Lens	-0.503	0.236 T <sub>3</sub>	1.638	23.256	-3.363	plastic
32		-0.776	0.065 G <sub>34</sub>				
41	Fourth Lens	3.278	0.740 T <sub>4</sub>	1.535	55.711	1.327	plastic
42		-0.838	0.051 G <sub>45</sub>				
51	Fifth Lens	2.616	0.370 T <sub>5</sub>	1.638	23.256	-1.466	plastic
52		0.655	0.400				
60	IR Filter	Infinity	0.210				
	IR Filter- Image Plane	Infinity	0.419				
71	Image Planc	Infinity					

FIG. 22



No.	11	12	21	22	31
K	-4.260E+00	7.493E+00	0.000E+00	1.928E+00	-6.729E-01
a4	1.349E-01	2.210E-01	-2.063E-01	-3.760E-01	4.836E-01
a6	2.321E-02	-2.927E-01	-5.522E-01	-5.012E-01	3.754E-01
a8	-2.482E-02	-1.019E-01	-5.975E-01	1.094E+00	1.421E+00
a10	1.700E-02	1.778E-01	-9.531E+00	-5.076E-01	-2.738E-01
a12	-1.861E-02	-5.836E-02	-9.532E+00	-1.816E-01	8.979E-02
a14	8.295E-03	-1.961E-01	-9.042E+00	-3.317E+00	0.000E+00
a16	-3.091E-02	2.145E-01	0.000E+00	0.000E+00	0.000E+00
a18	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00
No.	32	41	42	51	52
K	-1.013E+00	-1.219E+01	-7.366E+00	-2.060E+00	-5.354E+00
a4	1.867E-01	4.527E-02	8.588E-02	-2.496E-01	-1.364E-01
a6	2.086E-01	-1.293E-02	8.573E-03	-6.829E-03	4.181E-02
a8	3.429E-02	-8.934E-02	-7.015E-03	3.263E-02	-9.799E-03
a10	-2.805E-01	1.196E-01	-1.093E-02	-1.303E-03	1.202E-03
a12	3.207E-01	-7.754E-02	7.378E-04	-2.083E-03	1.308E-04
a14	0.000E+00	1.295E-02	2.124E-03	-1.118E-04	-1.376E-04
a16	0.000E+00	1.655E-03	-5.417E-04	1.489E-04	2.214E-05
a18	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00

FIG. 23

Third Example							
F= 2.12 mm, HFOV= 46.334 deg., Fno= 2.388							
No.		Curvature Radius	Ape. Stop Distance Lens Thickness Air Gap	Refractive Index	Abbe No.	Focal Length	Material
	Object	Infinity	500				
		Infinity	0.050				
11	First Lens	2.968	0.339 T <sub>1</sub>	1.535	55.711	10.999	plastic
12		5.731	0.356 G <sub>12</sub>				
80	Ape. Stop	Infinity	0.094				
21	Second Lens	3.842	0.535 T <sub>2</sub>	1.535	55.711	2.472	plastic
22		-1.928	0.219 G <sub>23</sub>				
31	Third Lens	-0.503	0.220 T <sub>3</sub>	1.638	23.256	-3.748	plastic
32		-0.744	0.050 G <sub>34</sub>				
41	Fourth Lens	8.222	0.671 T <sub>4</sub>	1.535	55.711	1.246	plastic
42		-0.708	0.083 G <sub>45</sub>				
51	Fifth Lens	2.335	0.273 T <sub>5</sub>	1.638	23.256	-1.423	plastic
52		0.627	0.400				
60	IR Filter	Infinity	0.210				
	IR Filter- Image Plane	Infinity	0.460				
71	Image Plane	Infinity					

FIG. 24

No.	11	12	21	22	31
K	-1.118E+01	3.302E+01	0.000E+00	2.270E+00	-6.979E-01
a4	1.292E-01	1.703E-01	-1.060E-01	-2.355E-01	6.089E-01
a6	6.336E-03	-2.100E-01	-3.245E-01	-6.165E-01	5.245E-01
a8	-5.452E-02	-7.023E-02	-2.061E-01	5.710E-01	5.458E-01
a10	7.506E-03	1.699E-01	-7.199E-01	-2.683E-01	-2.549E-01
a12	-1.470E-02	-8.238E-02	-9.876E-02	5.778E-01	2.303E-01
a14	1.854E-02	-2.098E-01	-2.167E-01	3.185E-01	0.000E+00
a16	-1.754E-02	1.635E-01	0.000E+00	0.000E+00	0.000E+00
a18	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00
No.	32	41	42	51	52
K	-1.15974E+00	2.05421E+01	-4.76160E+00	-2.00125E+00	-5.21693E+00
a4	2.58159E-01	1.01722E-01	7.55121E-02	-2.52948E-01	-1.69990E-01
a6	2.73978E-01	-5.49933E-02	8.61327E-03	-1.00291E-02	4.87545E-02
a8	-3.22001E-02	-9.59208E-02	-6.21087E-03	3.12518E-02	-9.12177E-03
a10	-3.73609E-01	1.29003E-01	-1.00392E-02	-1.35048E-03	1.19018E-03
a12	2.13973E-01	-6.94715E-02	1.29636E-03	-1.97998E-03	1.00789E-04
a14	0.00000E+00	1.47144E-02	2.37778E-03	-1.72062E-05	-1.51385E-04
a16	0.00000E+00	-4.07578E-03	-4.73790E-04	2.11545E-04	1.91047E-05
a18	0.00000E+00	0.00000E+00	0.00000E+00	0.00000E+00	0.00000E+00

FIG. 25

Fourth Example							
F= 2.006 mm, HFOV= 47.689 deg., Fno= 2.442							
No.		Curvature Radius	Ape. Stop Distance Lens Thickness Air Gap	Refractive Index	Abbe No.	Focal Length	Material
	Object	Infinity	500				
		Infinity	0.050				
11	First Lens	2.108	0.595 T <sub>1</sub>	1.535	55.711	7.474	plastic
12		4.004	0.181 G <sub>12</sub>				
80	Ape. Stop	Infinity	0.068				
21	Second Lens	-225.448	0.481 T <sub>2</sub>	1.535	55.711	2.579	plastic
22		-1.377	0.193 G <sub>23</sub>				
31	Third Lens	-0.489	0.217 T <sub>3</sub>	1.638	23.256	-3.671	plastic
32		-0.724	0.040 G <sub>34</sub>				
41	Fourth Lens	4.273	0.661 T <sub>4</sub>	1.535	55.711	1.334	plastic
42		-0.814	0.070 G <sub>45</sub>				
51	Fifth Lens	2.038	0.373 T <sub>5</sub>	1.638	23.256	-1.453	plastic
52		0.595	0.400				
60	IR Filter	Infinity	0.210				
	IR Filter- Image Plane	Infinity	0.298				
71	Image Plane	Infinity					

FIG. 26

No.	11	12	21	22	31
K	-5.799E+00	-9.535E+00	0.000E+00	1.426E+00	-6.707E-01
a4	1.229E-01	1.949E-01	-2.719E-01	-3.681E-01	4.564E-01
a6	1.073E-02	-3.648E-01	-2.340E-01	-5.760E-01	3.163E-01
a8	-3.102E-02	-1.120E-01	-2.491E+00	9.017E-01	1.627E+00
a10	2.018E-02	2.633E-01	-4.492E+00	-7.026E-01	-2.829E-01
a12	-1.138E-02	-6.315E-02	-1.165E+00	-3.695E+00	-2.695E-01
a14	1.350E-02	-3.342E-01	1.025E+02	-1.171E+00	0.000E+00
a16	-2.836E-02	4.369E-01	0.000E+00	0.000E+00	0.000E+00
a18	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00
No.	32	41	42	51	52
K	-8.751E-01	-1.329E-01	-6.875E+00	-2.180E+00	-4.804E+00
a4	1.447E-01	5.479E-02	8.505E-02	-2.508E-01	-1.392E-01
a6	2.085E-01	-1.809E-02	7.717E-03	-7.563E-03	4.306E-02
a8	4.075E-02	-8.937E-02	-7.191E-03	3.189E-02	-9.578E-03
a10	-2.826E-01	1.212E-01	-1.087E-02	-1.344E-03	1.233E-03
a12	2.666E-01	-7.672E-02	7.804E-04	-2.083E-03	1.322E-04
a14	0.000E+00	1.339E-02	2.111E-03	-1.024E-04	-1.397E-04
a16	0.000E+00	1.956E-03	-5.565E-04	1.578E-04	2.243E-05
a18	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00

FIG. 27

Fifth Example							
F= 1.882 mm, HFOV= 49.797 deg., Fno= 2.42							
No.		Curvature Radius	Ape. Stop Distance Lens Thickness Air Gap	Refractive Index	Abbe No.	Focal Length	Material
	Object	Infinity	500				
		Infinity	0.05				
11	First Lens	4.088	0.305 T <sub>1</sub>	1.535	55.711	34.758	plastic
12		5.099	0.350 G <sub>12</sub>				
80	Ape. Stop	Infinity	0.074				
21	Second Lens	10.201	0.517 T <sub>2</sub>	1.535	55.711	2.304	plastic
22		-1.383	0.299 G <sub>23</sub>				
31	Third Lens	-0.493	0.220 T <sub>3</sub>	1.638	23.256	-3.276	plastic
32		-0.756	0.050 G <sub>34</sub>				
41	Fourth Lens	4.430	0.724 T <sub>4</sub>	1.535	55.711	1.121	plastic
42		-0.657	0.050 G <sub>45</sub>				
51	Fifth Lens	0.979	0.220 T <sub>5</sub>	1.638	23.256	-1.379	plastic
52		0.424	0.400				
60	IR Filter	Infinity	0.210				
	IR Filter- Image Plane	Infinity	0.482				
71	Image Plane	Infinity					

FIG. 28

No.	11	12	21	22	31
K	1.633E+00	1.300E+01	0.000E+00	3.275E+00	-6.682E-01
a4	1.475E-01	2.438E-01	-2.725E-01	-2.895E-01	4.998E-01
a6	-2.818E-02	-2.451E-01	-4.875E-01	-3.329E-01	5.929E-02
a8	-4.090E-02	-1.258E-01	-3.306E+00	-5.821E-01	1.357E+00
a10	1.091E-02	8.918E-02	1.323E+00	-2.703E-01	-2.824E-01
a12	-2.874E-02	-1.541E-01	-2.388E+01	6.055E+00	7.627E-01
a14	1.418E-03	-2.282E-01	-2.328E+01	-1.343E+01	0.000E+00
a16	-2.327E-02	3.969E-01	0.000E+00	0.000E+00	0.000E+00
a18	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00
No.	32	41	42	51	52
K	-9.093E-01	-5.672E+01	-6.386E+00	-6.080E+00	-3.640E+00
a4	1.236E-01	2.273E-02	-8.848E-02	-1.938E-01	-1.691E-01
a6	3.087E-01	6.106E-03	7.628E-02	-2.817E-02	4.819E-02
a8	8.924E-02	-9.134E-02	-9.045E-03	2.295E-02	-1.139E-02
a10	-3.382E-01	1.095E-01	-1.851E-02	-2.076E-03	1.295E-03
a12	1.206E-01	-7.529E-02	-6.391E-05	-1.775E-03	2.281E-04
a14	0.000E+00	1.760E-02	2.640E-03	8.082E-05	-1.319E-04
a16	0.000E+00	8.460E-04	6.565E-04	2.923E-04	1.549E-05
a18	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00

FIG. 29

Sixth Example							
F= 2.59 mm, HFOV= 41.067 deg., Fno= 2.51							
No.		Curvature Radius	Apc. Stop Distance Lens Thickness Air Gap	Refractive Index	Abbe No.	Focal Length	Material
	Object	Infinity	500				
		Infinity	0.050				
11	First Lens	1.917	0.287 T <sub>1</sub>	1.535	55.711	6.281	plastic
12		4.212	0.051 G <sub>12</sub>				
80	Ape. Stop	Infinity	0.111				
21	Second Lens	5.249	0.491 T <sub>2</sub>	1.535	55.711	2.739	plastic
22		-1.975	0.368 G <sub>23</sub>				
31	Third Lens	-0.509	0.220 T <sub>3</sub>	1.638	23.256	-1.904	plastic
32		-1.019	0.050 G <sub>34</sub>				
41	Fourth Lens	12.493	0.447 T <sub>4</sub>	1.535	55.711	2.371	plastic
42		-1.400	0.060 G <sub>45</sub>				
51	Fifth Lens	2.331	0.810 T <sub>5</sub>	1.638	23.256	-7.978	plastic
52		1.385	0.400				
60	IR Filter	Infinity	0.210				
	IR Filter- Image Plane	Infinity	0.447				
71	Image Plane	Infinity					

FIG. 30



No.	11	12	21	22	31
K	-8.355E+00	-1.177E+02	0.000E+00	-1.950E+00	-6.221E-01
a4	1.958E-02	-5.618E-02	-1.813E-01	-2.119E-01	5.206E-01
a6	-2.694E-01	-9.055E-01	-2.211E-01	-6.912E-01	-1.045E-01
a8	-2.638E-01	1.805E+00	-2.617E+00	4.022E-01	7.197E-01
a10	-1.194E-01	-5.275E+00	9.068E+00	-7.422E-01	-5.904E-01
a12	-6.403E-02	-1.102E+01	-2.783E+01	-2.217E+00	3.116E+00
a14	-2.298E-01	7.839E+01	2.623E+01	4.246E+00	0.000E+00
a16	-1.020E+00	-9.747E+01	0.000E+00	0.000E+00	0.000E+00
a18	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00
No.	32	41	42	51	52
K	-3.963E-01	-1.950E+03	-6.878E+00	-1.002E-01	-7.201E+00
a4	-4.006E-02	3.158E-02	1.823E-01	-1.350E-01	-6.360E-02
a6	2.348E-01	4.089E-02	-4.643E-02	3.878E-03	2.040E-02
a8	2.076E-01	-1.368E-01	-2.100E-02	1.862E-02	-8.395E-03
a10	-2.447E-01	9.325E-02	-1.654E-02	-4.114E-03	1.670E-03
a12	8.624E-02	-9.954E-02	-1.466E-03	-1.926E-03	2.137E-04
a14	0.000E+00	1.857E-02	2.590E-03	9.424E-05	-1.364E-04
a16	0.000E+00	6.170E-03	1.380E-03	1.631E-04	1.405E-05
a18	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00

FIG. 31

Seventh Example							
F= 2.394 mm, HFOV= 43 deg., Fno= 2.431							
No.		Curvature Radius	Ape. Stop Distance Lens Thickness Air Gap	Refractive Index	Abbe No.	Focal Length	Material
	Object	Infinity	500				
		Infinity	0.050				
11	First Lens	1.306	0.407 T <sub>1</sub>	1.535	55.711	3.854	plastic
12		3.157	0.157 G <sub>12</sub>				
80	Ape. Stop	Infinity	0.150				
21	Second Lens	204.526	0.324 T <sub>2</sub>	1.535	55.711	3.847	plastic
22		-2.085	0.252 G <sub>23</sub>				
31	Third Lens	-0.549	0.234 T <sub>3</sub>	1.638	23.256	-7.972	plastic
32		-0.717	0.050 G <sub>34</sub>				
41	Fourth Lens	-50.118	0.582 T <sub>4</sub>	1.535	55.711	1.623	plastic
42		-0.860	0.070 G <sub>45</sub>				
51	Fifth Lens	2.782	0.305 T <sub>5</sub>	1.638	23.256	-1.420	plastic
52		0.658	0.400				
60	IR Filter	Infinity	0.210				
	IR Filter- Image Plane	Infinity	0.327				
71	Image Plane	Infinity					

FIG. 32

No.	11	12	21	22	31
K	-2.700E+00	-3.594E+01	0.000E+00	-6.997E+00	-6.602E-01
a4	1.485E-01	1.553E-01	-2.197E-01	-2.374E-01	4.253E-01
a6	1.712E-02	-3.632E-01	-4.910E-02	-3.652E-01	2.366E-01
a8	-7.842E-02	-1.606E-01	-1.136E+00	1.342E+00	1.399E+00
a10	-8.052E-02	1.683E-01	2.055E+00	-9.139E-01	-5.378E-01
a12	-1.395E-01	3.518E-02	-1.487E+01	-3.687E+00	-2.598E-01
a14	-8.869E-02	-9.778E-02	2.756E+01	6.777E+00	0.000E+00
a16	-2.629E-02	-2.813E-01	0.000E+00	0.000E+00	0.000E+00
a18	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00
No.	32	41	42	51	52
K	-8.639E-01	-2.242E+03	-7.546E+00	-8.852E-01	-5.871E+00
a4	1.434E-01	6.854E-02	6.598E-02	-2.426E-01	-1.405E-01
a6	1.618E-01	-2.358E-02	2.860E-03	-1.920E-03	4.119E-02
a8	6.197E-02	-9.557E-02	-7.168E-03	3.251E-02	-9.940E-03
a10	-2.100E-01	1.209E-01	-9.258E-03	-2.127E-03	1.225E-03
a12	2.516E-01	-7.507E-02	1.487E-03	-2.594E-03	1.506E-04
a14	0.000E+00	1.441E-02	2.008E-03	-2.319E-04	-1.356E-04
a16	0.000E+00	2.255E-03	-8.611E-04	1.605E-04	2.231E-05
a18	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00

FIG. 33

Eighth Example							
F= 2.113 mm, HFOV= 47.149 deg., Fno= 2.426							
No.		Curvature Radius	Apc. Stop Distance Lens Thickness Air Gap	Refractive Index	Abbe No.	Focal Length	Material
	Object	Infinity	500				
		Infinity	0.05				
11	First Lens	2.289	0.361 T <sub>1</sub>	1.535	55.711	6.942	plastic
12		5.608	0.144 G <sub>12</sub>				
80	Ape. Stop	Infinity	0.008				
21	Second Lens	30.805	0.640 T <sub>2</sub>	1.535	55.711	2.066	plastic
22		-1.142	0.205 G <sub>23</sub>				
31	Third Lens	-0.468	0.379 T <sub>3</sub>	1.638	23.256	-4.146	plastic
32		-0.748	0.048 G <sub>34</sub>				
41	Fourth Lens	4.857	0.850 T <sub>4</sub>	1.535	55.711	1.327	plastic
42		-0.784	0.049 G <sub>45</sub>				
51	Fifth Lens	3.165	0.254 T <sub>5</sub>	1.638	23.256	-1.333	plastic
52		0.653	0.400				
60	IR Filter	Infinity	0.210				
	IR Filter- Image Plane	Infinity	0.437				
71	Image Plane	Infinity					

FIG. 34

No.	11	12	21	22	31
K	-5.125E+00	1.425E+01	1.022E+03	8.776E-01	-7.421E-01
a4	1.376E-01	2.279E-01	-1.326E-01	-1.330E-01	3.743E-01
a6	2.217E-02	-2.817E-01	3.622E-02	-3.223E-01	3.912E-01
a8	-2.218E-02	-5.076E-02	-2.647E-01	5.959E-01	6.082E-01
a10	2.660E-02	3.226E-01	-1.006E+00	-7.999E-01	3.373E-01
a12	-5.314E-03	2.047E-01	-8.250E-01	8.334E-02	6.092E-01
a14	2.893E-02	6.056E-01	-1.006E+00	-5.223E-01	0.000E+00
a16	-1.483E-02	5.469E-01	0.000E+00	0.000E+00	0.000E+00
a18	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00
No.	32	41	42	51	52
K	-9.252E-01	6.272E+00	-8.521E+00	-1.473E+00	-6.419E+00
a4	1.482E-01	5.910E-02	5.037E-02	-2.182E-01	-1.580E-01
a6	1.417E-01	-1.939E-02	2.988E-03	-8.638E-03	5.103E-02
a8	2.499E-02	-9.503E-02	-7.925E-03	3.305E-02	-8.531E-03
a10	-3.003E-01	1.188E-01	-1.132E-02	-1.789E-03	1.140E-03
a12	3.224E-01	-7.204E-02	7.180E-04	-2.269E-03	1.055E-04
a14	0.000E+00	1.309E-02	2.331E-03	-1.310E-04	-1.480E-04
a16	0.000E+00	1.594E-03	-4.750E-04	1.240E-04	2.172E-05
a18	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00

FIG. 35

	Example 1	Example 2	Example 3	Example 4	Example 5	Example 6	Example 7	Example 8
$L_{\text{tt}}$	4.232	3.956	3.909	3.787	3.900	3.952	3.467	3.984
$T_{\text{all}}$	2.513	2.392	2.038	2.327	1.985	2.255	1.851	2.484
$G_{\text{aa}}$	0.571	0.535	0.801	0.553	0.823	0.640	0.679	0.453
$L_{\text{tt}}/T_{\text{all}}$	1.684	1.654	1.918	1.628	1.965	1.752	1.874	1.604
$L_{\text{tt}}/G_{\text{aa}}$	7.406	7.391	4.879	6.854	4.739	6.178	5.103	8.801
$L_{\text{tt}}/T_1$	10.253	8.998	11.542	6.362	12.787	13.748	8.525	11.025
$L_{\text{tt}}/G_{12}$	24.703	13.020	8.697	15.210	9.199	24.413	11.292	26.284
$L_{\text{tt}}/T_2$	5.970	6.531	7.301	7.874	7.548	8.050	10.715	6.224
$L_{\text{tt}}/T_5$	11.995	10.699	14.310	10.164	17.756	4.880	11.365	15.694
$T_{\text{all}}/G_{12}$	14.672	7.872	4.534	9.345	4.682	13.931	6.027	16.390
$T_{\text{all}}/G_{23}$	10.585	20.766	9.325	12.028	6.641	6.131	7.346	12.123
$T_{\text{all}}/T_4$	3.137	3.230	3.038	3.522	2.743	5.045	3.181	2.922
$G_{\text{aa}}/T_3$	2.402	2.266	3.642	2.543	3.740	2.907	2.909	1.195

FIG. 36

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# OPTICAL IMAGING LENS AND ELECTRONIC DEVICE COMPRISING THE SAME

## CROSS REFERENCE TO RELATED APPLICATION

This application claims priority to China Application No. 201310472665.8, filed on Oct. 11, 2013.

## BACKGROUND OF THE INVENTION

### 1. Field of the Invention

The present invention generally relates to an optical imaging lens set and an electronic device which includes such optical imaging lens set. Specifically speaking, the present invention is directed to an optical imaging lens set of reduced length and an electronic device which includes such optical imaging lens set.

### 2. Description of the Prior Art

In recent years, the popularity of mobile phones and digital cameras makes the photographic modules of various portable electronic products, such as optical imaging lens elements, holders or an image sensor . . . develop quickly, and the shrinkage of mobile phones and digital cameras also makes a greater and greater demand for the miniaturization of the photography module. The current trend of research is to develop an optical imaging lens set of a shorter length with uncompromised good quality.

With the development and shrinkage of a charge coupled device (CCD) or a complementary metal oxide semiconductor element (CMOS), the optical imaging lens set installed in the photography module shrinks as well to meet the demands. However, good and necessary optical properties, such as the system aberration improvement, as well as production cost and production feasibility should be taken into consideration, too.

An optical imaging lens set made of five lens elements is known. For example, US 2007236811 discloses an optical imaging lens set made of five lens elements. Its distortion is up to 5% so the optical imaging lens set is not good at reducing distortion. The total length of the optical imaging lens set is up to 12 mm so it is not suitable for an electronic device of 10 mm thickness.

Further, US 2007229984 discloses another optical imaging lens sets made of five lens elements. Although the image quality is better and the total length is as small as 8 mm, these disclosed dimensions do not show good examples of the shrinkage of portable electronic products, such as mobile phones and digital cameras.

It is still a problem, on one hand, to reduce the system length efficiently and, on the other hand, to maintain a sufficient optical performance in this field.

## SUMMARY OF THE INVENTION

In the light of the above, the present invention is capable of proposing an optical imaging lens set of lightweight, low production cost, reduced length, high resolution and high image quality. The optical imaging lens set of five lens elements of the present invention has a first lens element, a second lens element, a third lens element, a fourth lens element and a fifth lens element sequentially from an object side to an image side along an optical axis.

Both the first lens element and the second lens element have positive refractive power. The third lens element has a third image-side surface facing toward the image side and the

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third image-side surface has a convex portion in a vicinity of the optical axis. The fourth lens element has an fourth image-side surface facing toward the image side and the fourth image-side surface has a convex portion in a vicinity of the optical axis. The fifth lens element is made of a plastic material and has a fifth image-side surface facing toward the image side and the fifth image-side surface has a concave portion in a vicinity of the optical axis and a convex portion in a vicinity of its circular periphery. The optical imaging lens set exclusively has five lens elements with refractive power. Each the first lens element, the second lens element, the third lens element, the fourth lens element and the fifth lens element has an object-side surface facing toward the object-side and an image-side surface facing toward the image side.

In the optical imaging lens set of four lens elements of the present invention, a distance  $L_{H'}$  from the first object-side surface to an imaging plane on the image side along the optical axis and the sum of all four air gaps  $G_{aa}$  between each lens element from the first lens element to the fifth lens element along the optical axis satisfy a relationship  $L_{H'}/G_{aa} \leq 7.5$ .

In the optical imaging lens set of four lens elements of the present invention, a thickness  $T_1$  of the first lens element along the optical axis satisfies a relationship  $L_{H'}/T_1 \leq 13.0$ .

In the optical imaging lens set of four lens elements of the present invention, the fourth lens element has a fourth object-side surface facing toward the object side and the object-side surface has a convex portion in a vicinity of the optical axis.

In the optical imaging lens set of four lens elements of the present invention, a thickness  $T_2$  of the second lens element along the optical axis satisfies a relationship  $L_{H'}/T_2 \leq 12.0$ .

In the optical imaging lens set of four lens elements of the present invention, the sum of all four air gaps  $G_{aa}$  between each lens element from the first lens element to the fifth lens element along the optical axis and a thickness  $T_3$  of the third lens element along the optical axis satisfy a relationship  $G_{aa}/T_3 \leq 5.0$ .

In the optical imaging lens set of four lens elements of the present invention, an air gap  $G_{12}$  between the first lens element and the second lens element along the optical axis satisfies a relationship  $L_{H'}/G_{12} \leq 25.0$ .

In the optical imaging lens set of four lens elements of the present invention, a thickness  $T_1$  of the first lens element along the optical axis satisfies a relationship  $L_{H'}/T_1 \leq 13.0$ .

In the optical imaging lens set of four lens elements of the present invention, the second lens element has an image-side surface facing toward the image side and the image-side surface has a convex portion in a vicinity of the optical axis.

In the optical imaging lens set of four lens elements of the present invention, the first lens element has a first image-side surface facing toward the image side and the first image-side surface has a concave portion in a vicinity of the optical axis.

In the optical imaging lens set of four lens elements of the present invention, the fifth lens element has an object-side surface facing toward the object side and the object-side surface having a convex portion in a vicinity of the optical axis.

In the optical imaging lens set of four lens elements of the present invention, a thickness  $T_1$  of the first lens element along the optical axis satisfies a relationship  $L_{H'}/T_1 \leq 13.0$ .

In the optical imaging lens set of four lens elements of the present invention, a thickness  $T_4$  of the fourth lens element along the optical axis satisfies a relationship  $T_{air}/T_4 \leq 5.2$ .

In the optical imaging lens set of four lens elements of the present invention, an air gap  $G_{12}$  between the first lens element and the second lens element along the optical axis satisfies a relationship  $L_{H'}/G_{12} \leq 25.0$ .

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In the optical imaging lens set of four lens elements of the present invention, a total thickness  $T_{all}$  of the first lens element, the second lens element, the third lens element and the fourth lens element along the optical axis satisfies a relationship  $L_{H1}/T_{all} \leq 2.0$ .

In the optical imaging lens set of four lens elements of the present invention, an air gap  $G_{23}$  between the second lens element and the third lens element along the optical axis satisfies a relationship  $T_{all}/G_{23} \leq 21.0$ .

In the optical imaging lens set of four lens elements of the present invention, an air gap  $G_{12}$  between the first lens element and the second lens element along the optical axis satisfies a relationship  $T_{all}/G_{12} \leq 17.5$ .

In the optical imaging lens set of four lens elements of the present invention, a thickness  $T_2$  of the second lens element along the optical axis satisfies a relationship  $L_{H2}/T_2 \leq 12.0$ .

In the optical imaging lens set of four lens elements of the present invention, a thickness  $T_5$  of the fifth lens element along the optical axis satisfies a relationship  $L_{H5}/T_5 \leq 13.0$ .

The present invention also proposes an electronic device which includes the optical imaging lens set as described above. The electronic device includes a case and an image module disposed in the case. The image module includes an optical imaging lens set as described above, a barrel for the installation of the optical imaging lens set, a module housing unit for the installation of the barrel, a substrate for the installation of the module housing unit and an image sensor disposed at the substrate and at an image side of the optical imaging lens set.

These and other objectives of the present invention will no doubt become obvious to those of ordinary skill in the art after reading the following detailed description of the preferred embodiment that is illustrated in the various figures and drawings.

## BRIEF DESCRIPTION OF THE DRAWINGS

FIG. 1 illustrates a first example of the optical imaging lens set of the present invention.

FIG. 2A illustrates the longitudinal spherical aberration on the image plane of the first example.

FIG. 2B illustrates the astigmatic aberration on the sagittal direction of the first example.

FIG. 2C illustrates the astigmatic aberration on the tangential direction of the first example.

FIG. 2D illustrates the distortion aberration of the first example.

FIG. 3 illustrates a second example of the optical imaging lens set of four lens elements of the present invention.

FIG. 4A illustrates the longitudinal spherical aberration on the image plane of the second example.

FIG. 4B illustrates the astigmatic aberration on the sagittal direction of the second example.

FIG. 4C illustrates the astigmatic aberration on the tangential direction of the second example.

FIG. 4D illustrates the distortion aberration of the second example.

FIG. 5 illustrates a third example of the optical imaging lens set of four lens elements of the present invention.

FIG. 6A illustrates the longitudinal spherical aberration on the image plane of the third example.

FIG. 6B illustrates the astigmatic aberration on the sagittal direction of the third example.

FIG. 6C illustrates the astigmatic aberration on the tangential direction of the third example.

FIG. 6D illustrates the distortion aberration of the third example.

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FIG. 7 illustrates a fourth example of the optical imaging lens set of four lens elements of the present invention.

FIG. 8A illustrates the longitudinal spherical aberration on the image plane of the fourth example.

FIG. 8B illustrates the astigmatic aberration on the sagittal direction of the fourth example.

FIG. 8C illustrates the astigmatic aberration on the tangential direction of the fourth example.

FIG. 8D illustrates the distortion aberration of the fourth example.

FIG. 9 illustrates a fifth example of the optical imaging lens set of four lens elements of the present invention.

FIG. 10A illustrates the longitudinal spherical aberration on the image plane of the fifth example.

FIG. 10B illustrates the astigmatic aberration on the sagittal direction of the fifth example.

FIG. 10C illustrates the astigmatic aberration on the tangential direction of the fifth example.

FIG. 10D illustrates the distortion aberration of the fifth example.

FIG. 11 illustrates a sixth example of the optical imaging lens set of four lens elements of the present invention.

FIG. 12A illustrates the longitudinal spherical aberration on the image plane of the sixth example.

FIG. 12B illustrates the astigmatic aberration on the sagittal direction of the sixth example.

FIG. 12C illustrates the astigmatic aberration on the tangential direction of the sixth example.

FIG. 12D illustrates the distortion aberration of the sixth example.

FIG. 13 illustrates a seventh example of the optical imaging lens set of four lens elements of the present invention.

FIG. 14A illustrates the longitudinal spherical aberration on the image plane of the seventh example.

FIG. 14B illustrates the astigmatic aberration on the sagittal direction of the seventh example.

FIG. 14C illustrates the astigmatic aberration on the tangential direction of the seventh example.

FIG. 14D illustrates the distortion aberration of the seventh example.

FIG. 15 illustrates an eighth example of the optical imaging lens set of four lens elements of the present invention.

FIG. 16A illustrates the longitudinal spherical aberration on the image plane of the eighth example.

FIG. 16B illustrates the astigmatic aberration on the sagittal direction of the eighth example.

FIG. 16C illustrates the astigmatic aberration on the tangential direction of the eighth example.

FIG. 16D illustrates the distortion aberration of the eighth example.

FIG. 17 illustrates exemplificative shapes of the optical imaging lens element of the present invention.

FIG. 18 illustrates a first preferred example of the portable electronic device with an optical imaging lens set of the present invention.

FIG. 19 illustrates a second preferred example of the portable electronic device with an optical imaging lens set of the present invention.

FIG. 20 shows the optical data of the first example of the optical imaging lens set.

FIG. 21 shows the aspheric surface data of the first example.

FIG. 22 shows the optical data of the second example of the optical imaging lens set.

FIG. 23 shows the aspheric surface data of the second example.



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FIG. 24 shows the optical data of the third example of the optical imaging lens set.

FIG. 25 shows the aspheric surface data of the third example.

FIG. 26 shows the optical data of the fourth example of the optical imaging lens set.

FIG. 27 shows the aspheric surface data of the fourth example.

FIG. 28 shows the optical data of the fifth example of the optical imaging lens set.

FIG. 29 shows the aspheric surface data of the fifth example.

FIG. 30 shows the optical data of the sixth example of the optical imaging lens set.

FIG. 31 shows the aspheric surface data of the sixth example.

FIG. 32 shows the optical data of the seventh example of the optical imaging lens set.

FIG. 33 shows the aspheric surface data of the seventh example.

FIG. 34 shows the optical data of the eighth example of the optical imaging lens set.

FIG. 35 shows the aspheric surface data of the eighth example.

FIG. 36 shows some important ratios in the examples.

#### DETAILED DESCRIPTION

Before the detailed description of the present invention, the first thing to be noticed is that in the present invention, similar (not necessarily identical) elements share the same numeral references. In the entire present specification, “a certain lens element has negative/positive refractive power” refers to the part in a vicinity of the optical axis of the lens element has negative/positive refractive power. “An object-side/image-side surface of a certain lens element has a concave/convex part or concave/convex portion” refers to the part is more concave/convex in a direction parallel with the optical axis to be compared with an outer region next to the region. Take FIG. 17 for example, the optical axis is “I” and the lens element is symmetrical with respect to the optical axis I. The object side of the lens element has a convex part in the region A, a concave part in the region B, and a convex part in the region C because region A is more convex in a direction parallel with the optical axis than an outer region (region B) next to region A, region B is more concave than region C and region C is similarly more convex than region E. “A circular periphery of a certain lens element” refers to a circular periphery region of a surface on the lens element for light to pass through, that is, region C in the drawing. In the drawing, imaging light includes Lc (chief ray) and Lm (marginal ray). “A vicinity of the optical axis” refers to an optical axis region of a surface on the lens element for light to pass through, that is, the region A in FIG. 17. In addition, the lens element may include an extension part E for the lens element to be installed in an optical imaging lens set. Ideally speaking, no light would pass through the extension part, and the actual structure and shape of the extension part is not limited to this and may have other variations. For the reason of simplicity, the extension part is not illustrated in the examples.

As shown in FIG. 1, the optical imaging lens set 1 of five lens elements of the present invention, sequentially from an object side 2 (where an object is located) to an image side 3 along an optical axis 4, has a first lens element 10, a second lens element 20, a third lens element 30, a fourth lens element 40, a fifth lens element 50, a filter 60 and an image plane 71. Generally speaking, the first lens element 10, the second lens

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element 20, the third lens element 30 and the fourth lens element 40 may be made of a transparent plastic material, but the present invention is not limited to this. The fifth lens element 50 is always made of a transparent plastic material. There are exclusively five lens elements with refractive power in the optical imaging lens set 1 of the present invention. The optical axis 4 is the optical axis of the entire optical imaging lens set 1, and the optical axis of each of the lens elements coincides with the optical axis of the optical imaging lens set 1.

Furthermore, the optical imaging lens set 1 includes an aperture stop (ape. stop) 80 disposed in an appropriate position. In FIG. 1, the aperture stop 80 is disposed between the first lens element 10 and the second lens element 20. When light emitted or reflected by an object (not shown) which is located at the object side 2 enters the optical imaging lens set 1 of the present invention, it forms a clear and sharp image on the image plane 71 at the image side 3 after passing through the first lens element 10, the aperture stop 80, the second lens element 20, the third lens element 30, the fourth lens element 40, the fifth lens element 50 and the filter 60.

In the embodiments of the present invention, the optional filter 60 may be a filter of various suitable functions, for example, the filter 60 may be an infrared cut filter (IR cut filter), placed between the fifth lens element 50 and the image plane 71.

Each lens element in the optical imaging lens set 1 of the present invention has an object-side surface facing toward the object side 2 as well as an image-side surface facing toward the image side 3. In addition, each object-side surface and image-side surface in the optical imaging lens set 1 of the present invention has a part in a vicinity of its circular periphery (circular periphery part) away from the optical axis 4 as well as a part in a vicinity of the optical axis (optical axis part) closer to the optical axis 4. For example, the first lens element 10 has an object-side surface 11 and an image-side surface 12; the second lens element 20 has an object-side surface 21 and an image-side surface 22; the third lens element 30 has an object-side surface 31 and an image-side surface 32; the fourth lens element 40 has an object-side surface 41 and an image-side surface 42; the fifth lens element 50 has an object-side surface 51 and an image-side surface 52.

Each lens element in the optical imaging lens set 1 of the present invention further has a central thickness T on the optical axis 4. For example, the first lens element 10 has a first lens element thickness  $T_1$ , the second lens element 20 has a second lens element thickness  $T_2$ , the third lens element 30 has a third lens element thickness  $T_3$ , the fourth lens element 40 has a fourth lens element thickness  $T_4$ , and the fifth lens element 50 has a fifth lens element thickness  $T_5$ . Therefore, the total thickness of all the lens elements in the optical imaging lens set 1 along the optical axis 4 is  $T_{all}=T_1+T_2+T_3+T_4+T_5$ .

In addition, between two adjacent lens elements in the optical imaging lens set 1 of the present invention there is an air gap G along the optical axis 4. For example, an air gap  $G_{12}$  is disposed between the first lens element 10 and the second lens element 20, an air gap  $G_{23}$  is disposed between the second lens element 20 and the third lens element 30, an air gap  $G_{34}$  is disposed between the third lens element 30 and the fourth lens element 40, an air gap  $G_{45}$  is disposed between the fourth lens element 40 and the fifth lens element 50. Therefore, the sum of total four air gaps between adjacent lens elements from the first lens element 10 to the fifth lens element 50 along the optical axis 4 is  $G_{aa}=G_{12}+G_{23}+G_{34}+G_{45}$ . Also, a distance from the first object-side 11 of the first lens

element **10** facing toward the object side **2** to an imaging plane **71** on the image side **3** along the optical axis **4** is  $L_{eff}$ .

#### First Example

Please refer to FIG. **1** which illustrates the first example of the optical imaging lens set **1** of the present invention. Please refer to FIG. **2A** for the longitudinal spherical aberration on the image plane **71** of the first example; please refer to FIG. **2B** for the astigmatic field aberration on the sagittal direction; please refer to FIG. **2C** for the astigmatic field aberration on the tangential direction, and please refer to FIG. **2D** for the distortion aberration. The Y axis of the spherical aberration in each example is "field of view" for 1.0. The Y axis of the astigmatic field and the distortion in each example stands for "image height".

The optical imaging lens set **1** of the first example has five lens elements **10** to **50**; each is made of a plastic material and has refractive power. The optical imaging lens set **1** also has a filter **60**, an aperture stop **80**, and an image plane **71**. The aperture stop **80** is provided between the first lens element **10** and the second lens element **20**. The filter **60** may be an infrared filter (IR cut filter) to prevent inevitable infrared in light reaching the image plane to adversely affect the imaging quality.

The first lens element **10** has positive refractive power. The object-side surface **11** of the first lens element **10** facing toward the object side **2** is a convex surface and the image-side surface **12** of the first lens element **10** facing toward the image side **3** is a concave surface. Both the object-side surface **11** and the image-side **12** of the first lens element **10** are aspherical surfaces.

The second lens element **20** has positive refractive power. The object-side surface **21** of the second lens element **20** facing toward the object side **2** has a convex part **23** (convex optical axis part) in the vicinity of the optical axis and a concave part **24** (concave circular periphery part) in a vicinity of its circular periphery. The image-side surface **22** of the second lens element **20** facing toward the image side **3** is a convex surface. In addition, both the object-side surface **21** and the image-side surface **22** of the second lens element **20** are aspherical surfaces.

The third lens element **30** has negative refractive power, an object-side surface **31** of the third lens element **30** facing toward the object side **2** and an image-side surface **32** of the third lens element **30** facing toward the image side **3**. The object-side surface **31** is a concave surface. The image-side surface **32** has a convex part **36** (convex optical axis part) in the vicinity of the optical axis and a convex part **37** (convex circular periphery part) in a vicinity of its circular periphery. In addition, both the object-side surface **31** and the image-side surface **32** of the third lens element **30** are aspherical surfaces.

The fourth lens element **40** has positive refractive power. The object-side surface **41** of the fourth lens element **40** facing toward the object side **2** has a convex part **43** (convex optical axis part) in the vicinity of the optical axis and a concave part **44** (concave circular periphery part) in a vicinity of its circular periphery. The image-side surface **42** of the fourth lens element **40** facing toward the image side **3** has a convex part **46** (convex optical axis part) in the vicinity of the optical axis and a convex part **47** (convex circular periphery part) in a vicinity of its circular periphery. In addition, both the object-side surface **41** and the image-side **42** of the fourth lens element **40** are aspherical surfaces.

The fifth lens element **50** has negative refractive power, an object-side surface **51** of the fifth lens element **50** facing toward the object side **2** and an image-side surface **52** of the

fifth lens element **50** facing toward the image side **3**. The object-side surface **51** has a convex part **53** (convex optical axis part) in the vicinity of the optical axis and a concave part **54** (concave circular periphery part) in a vicinity of its circular periphery. The image-side surface **52** has a concave part **56** (concave optical axis part) in the vicinity of the optical axis and a convex part **57** (convex circular periphery part) in a vicinity of its circular periphery. Further, both the object-side surface **51** and the image-side **52** of the fifth lens element **50** are aspherical surfaces. The filter **60** may be an infrared cut filter, and is disposed between the fifth lens element **50** and the image plane **71**.

In the optical imaging lens element **1** of the present invention, the object side **11/21/31/41/51** and image side **12/22/32/42/52** from the first lens element **10** to the fifth lens element **50**, total of ten surfaces are all aspherical. These aspheric coefficients are defined according to the following formula:

$$Z(Y) = \frac{Y^2}{R} / \left( 1 + \sqrt{1 - (1 + K) \frac{Y^2}{R^2}} \right) + \sum_{i=1}^n a_{2i} \times Y^{2i}$$

In which:

R represents the curvature radius of the lens element surface;

Z represents the depth of an aspherical surface (the perpendicular distance between the point of the aspherical surface at a distance Y from the optical axis and the tangent plane of the vertex on the optical axis of the aspherical surface);

Y represents a vertical distance from a point on the aspherical surface to the optical axis;

K is a conic constant;

$a_{2i}$  is the aspheric coefficient of the 2i order.

The optical data of the first example of the optical imaging lens set **1** are shown in FIG. **20** while the aspheric surface data are shown in FIG. **21**. In the following examples of the optical imaging lens set, the f-number of the entire optical lens element system is Fno, HFOV stands for the half field of view which is half of the field of view of the entire optical lens element system, and the unit for the curvature radius, the thickness and the focal length is in millimeters (mm), and F is a system focal length  $E_{f1}$  of the optical imaging lens set **1**. The length of the optical imaging lens set is 4.231 mm (from the first object-side surface to the image plane along the optical axis). The image height is 2.268 mm. Some important ratios of the first example are as follows:

$$\begin{aligned} L_{eff}/T_{all} &= 1.684 \\ L_{eff}/G_{aa} &= 7.406 \\ L_{eff}/T_1 &= 10.253 \\ L_{eff}/G_{12} &= 24.703 \\ L_{eff}/T_2 &= 5.970 \\ L_{eff}/T_5 &= 11.995 \\ T_{all}/G_{12} &= 14.672 \\ T_{all}/G_{23} &= 10.585 \\ T_{all}/T_4 &= 3.137 \\ G_{aa}/T_3 &= 2.402 \end{aligned}$$

#### Second Example

Please refer to FIG. **3** which illustrates the second example of the optical imaging lens set **1** of the present invention. Please refer to FIG. **4A** for the longitudinal spherical aberration on the image plane **71** of the second example; please refer to FIG. **4B** for the astigmatic aberration on the sagittal direction; please refer to FIG. **4C** for the astigmatic aberration on

the tangential direction, and please refer to FIG. 4D for the distortion aberration. The second example is similar with the first example with different optical data. The optical data of the second example of the optical imaging lens set are shown in FIG. 22 while the aspheric surface data are shown in FIG. 23. The length of the optical imaging lens set is 3.956 mm. The image height is 2.268 mm. Some important ratios of the second example are as follows:

$$\begin{aligned} L_{it}/T_{all} &= 1.654 \\ L_{it}/G_{aa} &= 7.391 \\ L_{it}/T_1 &= 8.998 \\ L_{it}/G_{12} &= 13.020 \\ L_{it}/T_2 &= 6.531 \\ L_{it}/T_5 &= 10.699 \\ T_{all}/G_{12} &= 7.872 \\ T_{all}/G_{23} &= 20.766 \\ T_{all}/T_4 &= 3.230 \\ G_{aa}/T_3 &= 2.266 \end{aligned}$$

#### Third Example

Please refer to FIG. 5 which illustrates the third example of the optical imaging lens set 1 of the present invention. Please refer to FIG. 6A for the longitudinal spherical aberration on the image plane 71 of the second example; please refer to FIG. 6B for the astigmatic aberration on the sagittal direction; please refer to FIG. 6C for the astigmatic aberration on the tangential direction, and please refer to FIG. 6D for the distortion aberration. The third example is similar with the first example with different optical data. The optical data of the third example of the optical imaging lens set are shown in FIG. 24 while the aspheric surface data are shown in FIG. 25. The length of the optical imaging lens set is 3.91 mm. The image height is 2.268 mm. Some important ratios of the third example are as follows:

$$\begin{aligned} L_{it}/T_{all} &= 1.918 \\ L_{it}/G_{aa} &= 4.879 \\ L_{it}/T_1 &= 11.542 \\ L_{it}/G_{12} &= 8.697 \\ L_{it}/T_2 &= 7.301 \\ L_{it}/T_5 &= 14.310 \\ T_{all}/G_{12} &= 4.534 \\ T_{all}/G_{23} &= 9.325 \\ T_{all}/T_4 &= 3.038 \\ G_{aa}/T_3 &= 3.642 \end{aligned}$$

#### Fourth Example

Please refer to FIG. 7 which illustrates the fourth example of the optical imaging lens set 1 of the present invention. Please refer to FIG. 8A for the longitudinal spherical aberration on the image plane 71 of the second example; please refer to FIG. 8B for the astigmatic aberration on the sagittal direction; please refer to FIG. 8C for the astigmatic aberration on the tangential direction, and please refer to FIG. 8D for the distortion aberration. The fourth example is similar with the first example except the optical data and the object-side surface 21 of the second lens element 20 has a concave part 23' (concave optical axis part) in the vicinity of the optical axis and a concave part 24 (concave circular periphery part) in a vicinity of its circular periphery. The optical data of the fourth example of the optical imaging lens set are shown in FIG. 26 while the aspheric surface data are shown in FIG. 27. The length of the optical imaging lens set is 3.787 mm. The image height is 2.268 mm. Some important ratios of the fourth example are as follows:

$$\begin{aligned} L_{it}/T_{all} &= 1.628 \\ L_{it}/G_{aa} &= 6.854 \\ L_{it}/T_1 &= 6.362 \\ L_{it}/G_{12} &= 15.210 \\ L_{it}/T_2 &= 7.874 \\ L_{it}/T_5 &= 10.164 \\ T_{all}/G_{12} &= 9.345 \\ T_{all}/G_{23} &= 12.028 \\ T_{all}/T_4 &= 3.522 \\ G_{aa}/T_3 &= 2.543 \end{aligned}$$

#### Fifth Example

Please refer to FIG. 9 which illustrates the fifth example of the optical imaging lens set 1 of the present invention. Please refer to FIG. 10A for the longitudinal spherical aberration on the image plane 71 of the second example; please refer to FIG. 10B for the astigmatic aberration on the sagittal direction; please refer to FIG. 10C for the astigmatic aberration on the tangential direction, and please refer to FIG. 10D for the distortion aberration. The fifth example is similar with the first example with different optical data. The optical data of the fifth example of the optical imaging lens set are shown in FIG. 28 while the aspheric surface data are shown in FIG. 29. The length of the optical imaging lens set is 3.899 mm. The image height is 2.268 mm. Some important ratios of the fifth example are as follows:

$$\begin{aligned} L_{it}/T_{all} &= 1.965 \\ L_{it}/G_{aa} &= 4.739 \\ L_{it}/T_1 &= 12.787 \\ L_{it}/G_{12} &= 9.199 \\ L_{it}/T_2 &= 7.548 \\ L_{it}/T_5 &= 17.756 \\ T_{all}/G_{12} &= 4.682 \\ T_{all}/G_{23} &= 6.641 \\ T_{all}/T_4 &= 2.743 \\ G_{aa}/T_3 &= 3.740 \end{aligned}$$

#### Sixth Example

Please refer to FIG. 11 which illustrates the sixth example of the optical imaging lens set 1 of the present invention. Please refer to FIG. 12A for the longitudinal spherical aberration on the image plane 71 of the second example; please refer to FIG. 12B for the astigmatic aberration on the sagittal direction; please refer to FIG. 12C for the astigmatic aberration on the tangential direction, and please refer to FIG. 12D for the distortion aberration. The sixth example is similar with the first example except the optical data and the object-side surface 11 of the first lens element 10 facing toward the object side 2 has a convex part 13 (convex optical axis part) in the vicinity of the optical axis and a concave part 14 (concave circular periphery part) in a vicinity of its circular periphery, and the image-side surface 12 of the first lens element 10 facing toward the image side 3 has a concave part 16 (concave optical axis part) in the vicinity of the optical axis and a convex part 17 (convex circular periphery part) in a vicinity of its circular periphery. The optical data of the sixth example of the optical imaging lens set are shown in FIG. 30 while the aspheric surface data are shown in FIG. 31. The length of the optical imaging lens set is 3.951 mm. The image height is 2.268 mm. Some important ratios of the sixth example are as follows:

$$\begin{aligned} L_{it}/T_{all} &= 1.752 \\ L_{it}/G_{aa} &= 6.178 \\ L_{it}/T_1 &= 13.748 \\ L_{it}/G_{12} &= 24.413 \end{aligned}$$

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$$\begin{aligned} L_{it}/T_2 &= 8.050 \\ L_{it}/T_5 &= 4.880 \\ T_{ait}/G_{12} &= 13.931 \\ T_{ait}/G_{23} &= 6.131 \\ T_{ait}/T_4 &= 5.045 \\ G_{aa}/T_3 &= 2.907 \end{aligned}$$

## Seventh Example

Please refer to FIG. 13 which illustrates the seventh example of the optical imaging lens set 1 of the present invention. Please refer to FIG. 14A for the longitudinal spherical aberration on the image plane 71 of the second example; please refer to FIG. 14B for the astigmatic aberration on the sagittal direction; please refer to FIG. 14C for the astigmatic aberration on the tangential direction, and please refer to FIG. 14D for the distortion aberration. The seventh example is similar with the first example except the optical data and the object-side surface 41 of the fourth lens element 40 facing toward the object side 2 has a concave part 43' (concave optical axis part) in the vicinity of the optical axis, a concave part 44 (concave circular periphery part) in a vicinity of its circular periphery and a convex part 45 between the optical axis part and the circular periphery part. The optical data of the seventh example of the optical imaging lens set are shown in FIG. 32 while the aspheric surface data are shown in FIG. 33. The length of the optical imaging lens set is 3.467 mm. The image height is 2.268 mm. Some important ratios of the sixth example are as follows:

$$\begin{aligned} L_{it}/T_{ait} &= 1.874 \\ L_{it}/G_{aa} &= 5.103 \\ L_{it}/T_1 &= 8.525 \\ L_{it}/G_{12} &= 11.292 \\ L_{it}/T_2 &= 10.715 \\ L_{it}/T_5 &= 11.365 \\ T_{ait}/G_{12} &= 6.027 \\ T_{ait}/G_{23} &= 7.346 \\ T_{ait}/T_4 &= 3.181 \\ G_{aa}/T_3 &= 2.909 \end{aligned}$$

## Eighth Example

Please refer to FIG. 15 which illustrates the eighth example of the optical imaging lens set 1 of the present invention. Please refer to FIG. 16A for the longitudinal spherical aberration on the image plane 71 of the eighth example; please refer to FIG. 10B for the astigmatic aberration on the sagittal direction; please refer to FIG. 10C for the astigmatic aberration on the tangential direction, and please refer to FIG. 10D for the distortion aberration. The eighth example is similar with the first example with different optical data. The optical data of the eighth example of the optical imaging lens set are shown in FIG. 34 while the aspheric surface data are shown in FIG. 35. The length of the optical imaging lens set is 3.985 mm. The image height is 2.268 mm. Some important ratios of the fifth example are as follows:

$$\begin{aligned} L_{it}/T_{ait} &= 1.604 \\ L_{it}/G_{aa} &= 8.801 \\ L_{it}/T_1 &= 11.025 \\ L_{it}/G_{12} &= 26.284 \\ L_{it}/T_2 &= 6.224 \\ L_{it}/T_5 &= 15.694 \\ T_{ait}/G_{12} &= 16.390 \\ T_{ait}/G_{23} &= 12.123 \\ T_{ait}/T_4 &= 2.922 \\ G_{aa}/T_3 &= 1.195 \end{aligned}$$

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Some important ratios in each example are shown in FIG. 36.

In the light of the above examples, the inventors observe the following features:

1) In each one of the above examples, the longitudinal spherical aberration, the astigmatic aberration and the distortion aberration are respectively less than  $\pm 0.05$  mm,  $\pm 0.15$  mm and  $\pm 2\%$ . By observing this, it is suggested that all curves of every wavelength are close to one another, which reveals off-axis light of different heights of every wavelength all concentrates on the image plane, and deviations of every curve also reveal that off-axis light of different heights are well controlled so the examples do improve the spherical aberration, the astigmatic aberration and the distortion aberration.

2) In addition, the distances amongst the three representing different wavelengths are pretty close to one another, which means light of the three representing different wavelengths goes to almost the same spot so that the aberration is greatly improved.

3) The system total length of the examples is smaller than 4.5 mm. The demonstrated first example may maintain a good optical performance and reduced lens set length to realize a smaller product design.

Given the above, the design and arrangement of the lens elements in the optical imaging lens set of the present invention provide excellent image quality.

In addition, it is found that there are some better ratio ranges for different optical data according to the above various important ratios. Better ratio ranges help the designers to design the better optical performance and an effectively reduced length of a practically possible optical imaging lens set. For example:

1.  $L_{it}/G_{aa} = 7.5$ . When  $L_{it}/G_{aa} = 7.5$ , the reduction ratio of the total gap  $G_{aa}$  with respect to the total length  $L_{it}$  is smaller. However, considering optical properties and fabrication capability, this relationship satisfies a better arrangement. Preferably, it is suggested that  $4.5 \leq L_{it}/G_{aa} \leq 7.5$ .

2.  $L_{it}/T_1 \leq 13.0$ . The first lens element 10 provides refractive power so it has larger thickness and is less possible to be thinner. When  $(L_{it}/T_1)$  is smaller than 13, it means that  $L_{it}$  is reduced at a larger ratio in order to reduce the total length of the optical imaging lens set. This relationship also proposes a better optical quality. It is suggested that  $6.0 \leq L_{it}/T_1 \leq 13.0$ .

3. The convex optical axis part of the object-side surface 41 of the fourth lens element 40 at the optical axis helps receive the light coming from the third lens element 30 to enhance the image quality more effectively.

4.  $L_{it}/T_2 \leq 12.0$ . When  $L_{it}/T_2 \leq 12.0$ , it means that the reduction ratio of  $T_2$  with respect to the total length  $L_{it}$  is smaller. However, considering optical properties and fabrication capability, this relationship satisfies a better arrangement. It is suggested that  $5.0 \leq L_{it}/T_2 \leq 12.0$ .

5.  $G_{aa}/T_3 \leq 5.0$ . When  $G_{aa}/T_3 \leq 5.0$ , it means that the reduction ratio of  $T_3$  with respect to the total gap  $G_{aa}$  is smaller. However, considering optical properties and fabrication capability, this relationship satisfies a better arrangement. It is suggested that  $1.0 \leq G_{aa}/T_3 \leq 5.0$ .

6.  $L_{it}/G_{12} \leq 25.0$ . When  $L_{it}/G_{12} \leq 25.0$ , it means that the reduction ratio of  $G_{12}$  with respect to the total length  $L_{it}$  is smaller so the gap  $G_{12}$  between the first lens element 10 and the second lens element 20 may be well kept to enhance the image quality. Preferably, it is suggested that  $8.0 \leq L_{it}/G_{12} \leq 25.0$ .

7.  $T_{ait}/T_4 \leq 5.2$ . When  $T_{ait}/T_4 \leq 5.2$ , it means that the reduction ratio of  $T_4$  with respect to the total length  $T_{ait}$  is smaller. However, considering optical properties and fabrication

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capability, this relationship satisfies a better arrangement. It is suggested that  $2.5 \leq T_{all}/T_4 \leq 5.2$ .

8. The convex optical axis part of the second image-side surface **22** of the second lens element **20** at the optical axis helps do better correction of the light path and enhance the image quality.

9. The concave part of the image-side surface **12** of the first lens element **10** at the optical axis helps light go closer to the second lens element **20** to enhance the image quality.

10. The convex part of the object-side surface **51** of the fifth lens element **50** at the optical axis helps do better aberration correction to enhance the image quality.

11.  $L_{it}/T_{all} \leq 2.0$ . When  $L_{it}/T_{all} \leq 2.0$ , it means that the reduction ratio of  $T_{all}$  with respect to the total length  $L_{it}$  is smaller. However, considering optical properties and fabrication capability, this relationship satisfies a better arrangement. It is suggested that,  $1.5 \leq L_{it}/T_{all} \leq 2.0$ .

12.  $T_{all}/G_{23} \leq 21.0$ . When  $T_{all}/G_{23} \leq 21.0$ , it means that the reduction ratio of  $G_{23}$  with respect to the total length  $T_{all}$  is smaller so the gap  $G_{23}$  between the second lens element **20** and the third lens element **30** may be well kept to enhance the image quality. Preferably, it is suggested that  $6.0 \leq T_{all}/G_{23} \leq 21.0$ .

13.  $T_{all}/G_{12} \leq 17.5$ . When  $T_{all}/G_{12} \leq 17.5$ , it means that the reduction ratio of  $G_{12}$  with respect to the total length  $T_{all}$  is smaller so the gap  $G_{12}$  between the first lens element **10** and the second lens element **20** may be well kept to enhance the image quality. Preferably, it is suggested that  $T_{all}/G_{12} \leq 17.5$ .

14.  $L_{it}/T_5 \leq 13.0$ . When  $L_{it}/T_5 \leq 13.0$ , it means that the reduction ratio of  $T_5$  with respect to the total length  $L_{it}$  is smaller. However, considering optical properties and fabrication capability, this relationship satisfies a better arrangement. It is suggested that  $4.5 \leq L_{it}/T_5 \leq 13.0$ .

The optical imaging lens set **1** of the present invention may be applied to a portable electronic device. Please refer to FIG. **18**. FIG. **18** illustrates a first preferred example of the optical imaging lens set **1** of the present invention for use in a portable electronic device **100**. The portable electronic device **100** includes a case **110**, and an image module **120** mounted in the case **110**. A mobile phone is illustrated in FIG. **18** as an example, but the portable electronic device **100** is not limited to a mobile phone.

As shown in FIG. **18**, the image module **120** includes the optical imaging lens set **1** as described above. FIG. **18** illustrates the aforementioned first example of the optical imaging lens set **1**. In addition, the portable electronic device **100** also contains a barrel **130** for the installation of the optical imaging lens set **1**, a module housing unit **140** for the installation of the barrel **130**, a substrate **172** for the installation of the module housing unit **140** and an image sensor **70** disposed at the substrate **172**, and at the image side **3** of the optical imaging lens set **1**. The image sensor **70** in the optical imaging lens set **1** may be an electronic photosensitive element, such as a charge coupled device or a complementary metal oxide semiconductor element. The image plane **71** forms at the image sensor **70**.

The image sensor **70** used here is a product of chip on board (COB) package rather than a product of the conventional chip scale package (CSP) so it is directly attached to the substrate **172**, and protective glass is not needed in front of the image sensor **70** in the optical imaging lens set **1**, but the present invention is not limited to this.

To be noticed in particular, the optional filter **60** may be omitted in other examples although the optional filter **60** is present in this example. The case **110**, the barrel **130**, and/or

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the module housing unit **140** may be a single element or consist of a plurality of elements, but the present invention is not limited to this.

Each one of the five lens elements **10**, **20**, **30**, **40** and **50** with refractive power is installed in the barrel **130** with air gaps disposed between two adjacent lens elements in an exemplary way. The module housing unit **140** has a lens element housing **141**, and an image sensor housing **146** installed between the lens element housing **141** and the image sensor **70**. However in other examples, the image sensor housing **146** is optional. The barrel **130** is installed coaxially along with the lens element housing **141** along the axis I-I', and the barrel **130** is provided inside of the lens element housing **141**.

Because the optical imaging lens set **1** of the present invention may be as short as 4.5 mm, this ideal length allows the dimensions and the size of the portable electronic device **100** to be smaller and lighter, but excellent optical performance and image quality are still possible. In such a way, the various examples of the present invention satisfy the need for economic benefits of using less raw materials in addition to satisfy the trend for a smaller and lighter product design and consumers' demands.

Please also refer to FIG. **19** for another application of the aforementioned optical imaging lens set **1** in a portable electronic device **200** in the second preferred example. The main differences between the portable electronic device **200** in the second preferred example and the portable electronic device **100** in the first preferred example are: the lens element housing **141** has a first seat element **142**, a second seat element **143**, a coil **144** and a magnetic component **145**. The first seat element **142** is for the installation of the barrel **130**, exteriorly attached to the barrel **130** and disposed along the axis I-I'. The second seat element **143** is disposed along the axis I-I' and surrounds the exterior of the first seat element **142**. The coil **144** is provided between the outside of the first seat element **142** and the inside of the second seat element **143**. The magnetic component **145** is disposed between the outside of the coil **144** and the inside of the second seat element **143**.

The first seat element **142** may pull the barrel **130** and the optical imaging lens set **1** which is disposed inside of the barrel **130** to move along the axis I-I', namely the optical axis **4** in FIG. **1**. The image sensor housing **146** is attached to the second seat element **143**. The filter **60**, such as an infrared filter, is installed at the image sensor housing **146**. Other details of the portable electronic device **200** in the second preferred example are similar to those of the portable electronic device **100** in the first preferred example so they are not elaborated again.

Those skilled in the art will readily observe that numerous modifications and alterations of the device and method may be made while retaining the teachings of the invention. Accordingly, the above disclosure should be construed as limited only by the metes and bounds of the appended claims.

What is claimed is:

**1.** An optical imaging lens set, comprising: a first lens element, an aperture stop, a second lens element, a third lens element, a fourth lens element and a plastic fifth lens element from an object side toward an image side in order along an optical axis and each lens element having refractive power, wherein:

said first lens element has positive refractive power;

said second lens element has positive refractive power;

said third lens element has a third image-side surface facing toward said image side and said third image-side surface has a convex portion in a vicinity of said optical axis;

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said fourth lens element has a fourth image-side surface facing toward said image side and said fourth image-side surface has a convex portion in a vicinity of said optical axis; and

said fifth lens element has a fifth image-side surface facing toward said image side and said fifth image-side surface has a concave portion in a vicinity of said optical axis and a convex portion in a vicinity of a circular periphery of said fifth lens element, wherein said optical imaging lens set exclusively has five lens elements with refractive power, and a distance  $L_{tt}$  from said first object-side surface to an imaging plane on said image side along said optical axis and an air gap  $G_{12}$  between said first lens element and said second lens element along said optical axis satisfy a relationship  $L_{tt}/G_{12} \leq 25.0$ .

2. The optical imaging lens set of claim 1, wherein said first lens element has a first image-side surface facing toward said image side and said first image-side surface has a concave portion in a vicinity of said optical axis.

3. The optical imaging lens set of claim 2, wherein said fifth lens element has a fifth object-side surface facing toward said object side and said fifth object-side surface has a convex portion in a vicinity of said optical axis.

4. The optical imaging lens set of claim 2, wherein said fourth lens element has a fourth object-side surface facing toward said object side and said fourth object-side surface has a convex portion in a vicinity of said optical axis.

5. The optical imaging lens set of claim 2, wherein a thickness  $T_2$  of said second lens element along said optical axis satisfies a relationship  $L_{tt}/T_2 \leq 12.0$ .

6. The optical imaging lens set of claim 5, wherein the sum of all four air gaps  $G_{aa}$  between each lens element from said first lens element to said fifth lens element along the optical axis and a thickness  $T_3$  of said third lens element along said optical axis satisfy a relationship  $G_{aa}/T_3 \leq 5.0$ .

7. The optical imaging lens set of claim 2, wherein a thickness  $T_1$  of said first lens element along said optical axis satisfies a relationship  $L_{tt}/T_1 \leq 13.0$ .

8. The optical imaging lens set of claim 3, wherein said second lens element has a second image-side surface facing toward said image side and said second image-side surface has a convex portion in a vicinity of said optical axis.

9. The optical imaging lens set of claim 2, wherein the sum of all four air gaps  $G_{aa}$  between each lens element from said first lens element to said fifth lens element along the optical axis satisfies a relationship  $L_{tt}/G_{aa} \leq 7.5$ .

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10. The optical imaging lens set of claim 9, wherein a thickness  $T_1$  of said first lens element along said optical axis satisfies a relationship  $L_{tt}/T_1 \leq 13.0$ .

11. The optical imaging lens set of claim 2, wherein a thickness  $T_1$  of said first lens element along said optical axis satisfies a relationship  $L_{tt}/T_1 \leq 13.0$ .

12. The optical imaging lens set of claim 11, wherein a total thickness  $T_{all}$  of said first lens element, said second lens element, said third lens element, said fourth lens element and said fifth lens element along said optical axis and a thickness  $T_4$  of said fourth lens element along said optical axis satisfy a relationship  $T_{all}/T_4 \leq 5.2$ .

13. The optical imaging lens set of claim 2, wherein a total thickness  $T_{all}$  of said first lens element, said second lens element, said third lens element, said fourth lens element and said fifth lens element along said optical axis satisfies a relationship  $L_{tt}/T_{all} \leq 2.0$ .

14. The optical imaging lens set of claim 13, wherein an air gap  $G_{23}$  between said second lens element and said third lens element along said optical axis satisfies a relationship  $T_{all}/G_{23} \leq 21.0$ .

15. The optical imaging lens set of claim 2, wherein a total thickness  $T_{all}$  of said first lens element, said second lens element, said third lens element, said fourth lens element and said fifth lens element along said optical axis and an air gap  $G_{12}$  between said first lens element and said second lens element along said optical axis satisfy a relationship  $T_{all}/G_{12} \leq 17.5$ .

16. The optical imaging lens set of claim 15, wherein a thickness  $T_2$  of said second lens element along said optical axis satisfies a relationship  $L_{tt}/T_2 \leq 12.0$ .

17. The optical imaging lens set of claim 16, wherein a thickness  $T_5$  of said fifth lens element along said optical axis satisfies a relationship  $L_{tt}/T_5 \leq 13.0$ .

18. An electronic device, comprising:

a case; and

an image module disposed in said case and comprising:

an optical imaging lens set of claim 1;

a barrel for the installation of said optical imaging lens set;

a module housing unit for the installation of said barrel;

a substrate for the installation of said module housing unit;

and

an image sensor disposed at an image side of said optical imaging lens set.

\* \* \* \* \*